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GOVERNMENT OF PAKISTAN

خاکہ توسیع کراچی پر رپورٹ

REPORT

ON

GREATER KARACHI PLAN

1952

ABOUT THIS BOOK

This book is actually a reproduction of the original report published in 1951. The photographs, however, have not been reproduced nor the charts except four essential ones. The copies printed in 1951 were very limited in number and their circulation was, therefore, restricted. Now that the Karachi Development Authority has undertaken revision of the Master Plan of Karachi, it has become necessary to make available copies of this report for the various Committees and Sub-Committees as well as individuals who would be associated with the preparation of the Master Plan for the Karachi Urban Region. This report is expected to serve as a useful reference and guide book for them.

December 1967.

M. AHMED ALI,
Chief Town Planner and Architect,
KARACHI DEVELOPMENT AUTHORITY.

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VATTENBYGGNADSBYRÅN (V.B.B.),
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April, 1952.

The Chairman,
Central Engineering Authority,
Government of Pakistan,
Karachi,
Pakistan.

Sir,

We have much pleasure in submitting herewith our Report on the Greater Karachi Plan, giving a general outline for the development of the city. The fundamentals of the Report are stated in the Introduction on pages 1-4.

The present Report is based on a Preliminary Report, submitted in December, 1949, which was prepared in order to decide the principles of the Plan at an early stage. The Preliminary Report determined such basic assumptions as the principle type of development, the location of the Capital (in conformity with the decision taken at the meeting with the Hon. Minister Abdus Sattar Pirzada on the 21st July, 1949), etc., and it comprised in embryo most of the subjects dealt with in the present Report. This initial Report has been thoroughly discussed at several meetings in the past few years and the different views and ideas expressed in this connection have been considered when preparing the present Report.

The original terms of reference are contained in your letters No. CEA-36(18)/49 of the 2nd/4th April, 1949, and the 11th May, 1949.

Even though, as is emphasized in the Report, a town plan must be continuously coordinated with the latest developments, modern ideas and fresh aspects, yet it is necessary for practical reasons to decide the layout of a plan for a definite period until a general revision is found desirable. As the present Report, in all essentials, is the result of deliberations with the authorities concerned, it is to be considered as the Final Report on the Greater Karachi Plan.

On behalf of the Consulting Engineers and Architects we desire to express our appreciation of the excellent facilities provided by, and the wholehearted cooperation of, the Hon. the Prime Minister, His Excellency Khwaja Nazimuddin, who was Governor-General of Pakistan when this Report was begun, and of His Excellency Liaquat Ali Khan, the late Prime Minister, and his Secretary, Mr. A. A. Hamid. We are also greatly indebted to the Minister of Food and Agriculture, the Hon. Abdus Sattar Pirzada, and to the present Minister of Health, the Hon. Dr. A. M. Malik.

We further desire to express our appreciation of the assistance rendered by the State Departments, including the Ministry of Defence, Ministry of Commerce and Works, Ministry of Education and Industries, Ministry of Communications, Ministry of Health, Ministry of Interior, and the Pakistan Public Works Department, and by the Governor of Sind, the Karachi Administration, Karachi Municipal Corporation, Karachi Port Trust, Karachi Joint Water Board and the Sind Industrial Trading Estates.

We are also greatly indebted for valuable assistance and advice rendered by the officers of these administrative bodies.

Finally, we wish to acknowledge the valuable services rendered by you and by the staff of the Central Engineering Authority; your great interest in the work and your efficient collaboration have been highly appreciated.

We remain, Sir,
Yours faithfully,
For VATTENBYGGNADSBYRÅN (VBB)

(Sd.) S. Lindström

(Sd.) B. Östnäs

on behalf of MERZ RENDEL VATTEN (PAKISTAN)

INTRODUCTION

Pakistan stands at the entrance to its life as a free and independent nation. Economic, cultural and political conditions will differ markedly from those of the past. These new conditions must constitute the background for planning the capital of Pakistan. In drawing up the Plan, it is necessary to appreciate the structure of that community which can and should develop and to adapt the Plan to this development. Even more, the design and character of the new city should express and in itself contribute to the furtherance of this development, the guiding principles of which the authors of the Plan have visualized as follows.

Faithful to the Islamic tradition, Pakistan will remain a democratic state. The country will be open to international intercourse in all fields, economic, cultural and political, while at the same time asserting its own individuality and that of Islam.

Cultural development will therefore be based on Islamic tradition blended with international culture. Pure materialism and the neglect of spiritual values, which to some extent has characterized western development during the industrial period, need not necessarily characterize Pakistan as it passes through the process of industrialization. Spiritual and ideological errors may be avoided, provided that the background of tradition is kept in mind and the future political aims closely adhered to.

The economic life will continue to be centred on agriculture, since the produce of the earth is the major natural resource. Agriculture will be rationalized and intensified—a process which, among other things, will reduce the number of persons employed in agriculture proper and increase the number in auxiliary occupations and industries. In addition, there will be a considerable growth of “service occupations” and industries devoted mainly to domestic consumption. By concentrating production to those branches of industry, commerce and agriculture to which Pakistan offers especially favourable conditions and where the labour invested can bring a high return, foreign trade relations will become advantageous for the country, and domestic consumption will increase. In all fields of production, the experience accumulated over more than a century of industrial development in the West will be turned to account. An increase in production and favourable foreign trade relations is the primary condition for raising the standard of living.

A numerical estimate of the probable future population of Pakistan is difficult to make. Certain information suggests that the birth-rate has been declining for the past 15 years. Far-reaching conclusions should not, however, be drawn from this, since the tendency observed may be due to coincidence. Nevertheless, it has been assumed in this Report that the birth-rate will gradually decrease, partly as a consequence of the general cultural and political developments. It may therefore be expected that an increase in food production will not be immediately consumed by an increase in population, but that, instead, the standard of living will be gradually raised. An increase from the present population of 75 million to about 100 million in the year 2000 is assumed.

How large a part of this population can be expected to be engaged in urban occupations and to reside in cities? For the past century the urban residents in the Indo-Pakistan subcontinent have been a rather constant but small percentage of the entire population. This fact must be ascribed partly to political conditions and partly to the economic structure of the country. The situation is now different. Bearing in mind the fundamental economic importance of agriculture in Pakistan even in the future, we would expect that the non-agricultural population, which now is 30 per cent of the entire population of Pakistan, will constitute about 55 per cent by the year 2000. This will give an urban population of more than 50 million.

Karachi, in its capacity as a port and a capital city, will have a great part of the population of the country concentrated in it. As a port, the city will attract commercial firms and certain types of industry; as a capital, it will attract many kinds of businesses and activities, financial institutions, and the central offices of savings societies, cultural organizations, and the like. Considering these factors, and after comparison with cities in other countries with equivalent functions, we estimate that the population of Karachi can rise in the next half century to about three million from the present figure of little over one million.

The standard of living in western countries some centuries ago was probably not unlike that which now obtains in the Indo-Pakistan subcontinent. However, the progress which required several hundreds of years in the West can probably be achieved in a considerably shorter time in Pakistan if the lessons from other parts of the world are assimilated and skilfully applied. It has therefore been assumed in the Master Plan that, by the beginning of next century, the standard of living of the population will, in the main, have reached the present level of that in Europe. The demands on service facilities, utilities, communications, recreational accommodation and the like should not be less, but in some respects greater, than they now are in Europe, because Pakistan in the course of its development may have to satisfy needs which have been neglected, at least for the present, in the West.

The real function of a town is to enliven and enrich the life of the people. Technical arrangements are not a goal in themselves; technical planning is secondary. The social, cultural and economic life is primary. Whether the Plan will attain its object depends on whether our conception of future social conditions corresponds to future realities, and whether we can foresee the technical and economic facilities of the future with some certainty and can avail ourselves of them.

The importance of preserving and upholding the basic concepts of the Plan in the face of temporary difficulties, which may give rise to demands requiring deviation from the Plan in favour of this or that current interest, stands out clearly against the background outlined above. This will be a serious task for the political leaders of the country.

The principle ideas of the Plan are condensed in the following.

The Heart of Pakistan

The Capital will be the heart of Pakistan. The focus of the Capital will be an open square for official ceremonies, public meetings and prayers; it will be the forecourt of the nation. This square will be enclosed by the House of Parliament, the principal Mosque, the Supreme Court of Justice and buildings for the state authorities and cultural institutions.

The Main Axis

The new Capital and the existing central business section should be given the possibility of growing together into one common core, built up around one axis only which will also form the link between the most important outer areas. This axis will have the practical function of connecting the various sections of the city; it will have the symbolic function of uniting the old and the new, tradition and progress, the multifarious individual activities with the common life. The Quaid-i-Azam monument should be located at the highest point of this axis. In the capital section the axis will open on to the centre of the public square, directly opposite the House of Parliament.

Different Functions in Different Specified Areas

The different functions of the city will be located in different areas. More than one function will be located in the same area if the functions concerned are interrelated. The different areas will be

situated along the traffic routes which unite all the separate areas of the city and form the skeleton of the Plan. The backbone of this skeleton is the main axis.

Community Life

The residential areas will consist of groups large enough to permit of the arrangement of amply-equipped local centres for cultural life, education and shopping. The primary groups—the Residential Units—will accommodate 2,500 (5,000) inhabitants centred about schools, mosques and shops; these groups are assembled in communities—the Neighbourhood Units—comprising about 40,000 inhabitants, each with its own richly-developed centre.

Differentiated Density of Population

The residential areas should be built up mainly of terraced houses of one or two storeys, but in the most central areas high blocks of flats should be constructed. The less densely settled outer areas, with their low buildings, will accommodate about 2-1/4 million persons, while about 3/4 million will reside partly in the compact heart of the city, which will coincide in the main with the present city, and partly in Clifton and the Municipal Gardens.

The City by the Sea

Karachi's coastal location is being exploited commercially. The Master Plan assumes a ten-fold increase in the capacity of the Port, and a construction of a canal system to the Indus. The sea not only brings to the city trade and profits, it also gives coolness and pleasure. Karachi should be extended to the ocean, and large residential areas and the most important places of recreation are planned along the coast. A promenade will be built at Clifton, and the "Riviera of the East" will develop on the beaches out towards Cape Monze.

Uniform Labour Market

The system of streets and general communications should be so planned that in the future it will be possible to travel quickly from any residential area to places of employment in different parts of the city. This will tend to create a uniform labour market over the whole city area. Such an organization of the city also provides good facilities for personal and cultural contacts.

Walking Distance

The places of employment and the residential areas should be so situated in relation to each other that most of those wishing to walk may live within convenient walking distance of their work. Officials and clerks should be able to live near the centre of the town, the workmen near the industrial areas. All communal facilities in the residential groups and districts should also be within convenient walking distance of all the dwellings. The maximum walking distance is limited to one mile.

Safe, Fast and Cheap Transport

Speed and safety are essential for an efficient traffic system. They are attained by separating fast and heavy traffic from other traffic. Public transport in the centre of the town will be catered for, not by tramways, but by local railways built underground or elevated. No access to highways from adjoining plots of land will be permitted, and crossings should be built at different levels. Highways should be built for high speed, local streets designed to prevent fast driving.

Residential areas should be planned for motor traffic entering from feeder streets along the outer boundaries of the area. Pedestrian traffic will flow towards the centre of the area where the railway station, many public amenities, etc., are situated. Thus, as motor traffic decreases towards the centre, pedestrian traffic will increase, and vice versa.

Since economy in urban transport depends on concentration of traffic to a strictly limited number of transport routes, and on the speed of the traffic, requirements for both concentration and high speed are met in the Plan. Concentration will make possible the use of large transport units involving lower costs per passenger. High speed traffic will mean the intense use of every single transport unit and will reduce the number of units needed.

Flexibility

Owing to the difficulty of foreseeing the true future development, the Plan must be capable of satisfying various requirements which may arise at different times. It must be possible to make areas available for needs other than those which can be foreseen at present, and also to allow for changes in the requirements in respect of the areas already included in the proposal. For this reason land has been reserved which, if not required, may be used for gardening or farming or remain undeveloped. Alternative transport facilities, such as buses, trams, and trains, will be employed, and it should be possible to change from one method of transport to another as development progresses. It must also be possible to apply the Plan by stages; it therefore contains recommendations for measures to be adopted in the first stage of development.

A Responsible Authority

To maintain the flexibility and consequent "vitality" of the Plan, its execution requires an administrative agency with the necessary technical means and authority. New legislation for planning and expropriation is required as a basis for the work of this agency.

THE NATURAL ENVIRONMENT

For the future development of Karachi the physical conditions are favourable, since its natural harbour facilities permit a considerable expansion of the port, and large areas of suitable land are available for building construction.

On the whole the climate is not unfavourable in spite of the oppressive heat during the summer months.

Suggested measures are:—

- (i) Reclamation of submerged or low-lying areas near the present built-up city. Such reclamation will be profitable, since it will save the cost of transport to outlying areas which otherwise would have to be utilized.
- (ii) The limitation of building heights to 13 storeys, due to the risk of earthquakes, and the requirement that high structures be designed to withstand lateral stresses of one-tenth of the force of gravity.
- (iii) The provision of means to husband existing water resources and increase the water supply, to augment the vegetation and prevent erosion, thus improving the landscape. Among the proposed measures are the execution of local irrigation systems, the cultivation of suitable plants, the restriction of grazing of cattle and sheep and a prohibition on keeping goats.

Karachi's Relation to its Natural Environment

A metropolis is seldom located in a certain place because the topographical, geological, and climatic conditions at that site are particularly favourable for urban development. On the contrary, the growth of the city is often a struggle against an inhospitable environment. The historical and social conditions arising out of human activity are the stronger factors in deciding the location of urban communities. A large city is not usually planned. It develops by degrees in a certain place because it happens to be well situated with respect to the populated regions and lines of communication, and because large investments made in a city and the surrounding area must be exploited to the full. Even very remote districts and areas play their part in developing these focal points for human life which the great cities constitute.

Karachi developed out of a small harbour settlement, the location of which was clearly conditioned by the topography. In the lagoon behind the sand bar between Hawkes Bay and Manora, there was a natural harbour on the otherwise unprotected, shelving coast. It was not the presence of a natural harbour, however, which gave rise to maritime trade, but the human need for communications, which required a port. In the shelter of the sand bar, it was possible to develop and deepen the harbour so that it meets the requirements for deep-draught vessels.

Even though physiographic conditions in general are not of decisive importance for the development of a city, it is nevertheless advisable, when locating new undertakings and investing in new installations, to consider the physiographic features and other natural circumstances, and to avoid sites and areas which are not favourably situated in this respect. As an introduction, therefore, some brief remarks will be made on some of the more important characteristics of the natural environment which could influence the development of Karachi, as a whole, or the exploitation of certain areas. Other such characteristics will be touched upon in other connections.

Topography and Geology

The topography of the Karachi area must be regarded as being, in the main, conducive to a continued expansion of the city. It is true that the areas close to the sea are low and partially surrounded by shallow water, but on the whole the areas to be considered for construction of buildings and related structures consist of ground which can be used without abnormal costs or complicated preparatory work.

Prof. M. B. Pithawalla writes in his book "An Introduction to Karachi", published in Karachi, 1949:—

"Low flat-topped hills and parallel or sub-parallel ridges devoid of vegetation, vast intervening grounds and dry river beds and other water channels are characteristic of Karachi's physical environment. Once belonging to the Tethys Sea, this land has risen from the great depths with the rising of the Himalayas, the last ripples of the surging land having been marked in the Mangho Pir hills, the Clifton, Manora, Ghizri hills and the Drigh Road dome. Very low dips and gentle domes of the tertiary rocks are an indication of petroliferous beds. The heights within the city limits ordinarily do not exceed 100 feet and gradually fall to 5 feet at Keamari. The rocks being soft and the climate being dry for the greater part of the year, there is the tremendous subaerial denudation of rocks and the simultaneous erosion of the coastline due to the stormy sea. Surface springs are generally found within denuded anticlines. Very few minerals of economic value can be secured in such a region. . . . Among the rock formations can be found the aeolian crescent-shaped sand-hills, littoral and deltaic shell banks, the post-Tertiary conglomerate, the Siwalik sandstone, miocene marine limestone affording good building stone and road metal and the inter-bedded clays of different kinds. Among the associated minerals are calcite found in the joint-planes of limestone gypsum overlying the Gaj formations, pockets of lignite and some ironstone in the Nari beds. Chances of manufacturing cement, bricks, tiles and alkali salts in Karachi are great."

Reclamation

Even though most of the land in the vicinity of Karachi is well suited for building construction, there are nevertheless certain areas, now lying near or below sea level, which it would be desirable to utilize.

As the present central area behind the harbour will continue to be an important focal point in the life of the city, the areas along the nearby beaches will be particularly well situated for building development, even though they are not physiographically the most favoured. There is reason, therefore, to study the character of these areas and the measures required for making them available.

In a discussion of the utilization of the low areas, the variation in the tide levels is of interest. According to available information, the following data are the most important:—

Mean High Water Springs	..	..	8.83
Mean High Water Neaps	..	..	6.88
Mean Sea Level	..	..	5.21
Mean Low Water Neaps	..	..	-3.55
Mean Low Water Springs Datum	..	..	-1.65
(Admiralty and K. P. T.)	..	..	0.00

It is not enough, however, to keep building construction above the highest of these levels, because abnormally high water levels can arise, for instance, through the simultaneous occurrence of very high tides and earthquakes with their epicentres in the ocean. If abnormally high water levels should coincide with heavy precipitation from a cyclone, there could also be difficulty in disposing of surface water from low areas. It is regarded as sufficient to keep above the level of 13 ft., the line to which the Karachi Port Trust carried the reclamation work, without running more than a reasonable risk.

Small sections of the area already built up are so low that they are subject to inundation from high tides and heavy runoff from rainfall. These disadvantages could be counteracted by some increase in the level of the land, by improving the drainage system and, if necessary, by embankments and a pumping system.

Where land below the 13 ft. level is not already built on, and is so situated that it should be intensively used, it should be raised to this level. Reclamation could make very large well-located areas available to the city. The work carried out so successfully by the Karachi Port Trust during previous decades should be continued and intensified. The areas between Keamari and Clifton, around Bath Island, and the beach area south-east of Clifton are of particular interest because they are near the centre of the city, the sea breeze gives them a relatively comfortable climate during the summer, and there is an excellent view over the ocean. The utilization of these latter areas requires levelling the sand, some filling, and also protection against the erosive action of the sea and the air. A protective wall is thus required along the beach, as well as measures to bind the drift sand. Even with this included, the cost of reclamation is very moderate when viewed in relation to the great advantage of having centrally located, and therefore valuable, land available.

The Master Plan assumes that reclamation work will be carried out north-east of Ghizri Creek outside the mouth of the Malir River and along the lower reaches of the Layari River, in addition to the work in the harbour area and the Keamari-Clifton area.

Earthquakes

On the earthquake map overleaf it can be seen that Karachi is situated in a dangerous zone and that epicentres of severe earthquakes have appeared not far from the city. A small part of West Pakistan—the area south of Lahore and Multan along the border of East Punjab and Rajputana—lies outside “the danger zone” of the map but in the zone in which damage may be caused by earthquakes originating in the danger zone.

The danger of earthquakes should be considered when building in Karachi, but, in the main, only to the extent that high structures should be designed with regard to the possibility of their being subjected to lateral stresses. It is considered adequate to provide for lateral stresses amounting to one-tenth of the force of gravity. The limitation of the height of the buildings might also be considered, as on the west coast of the United States. In Los Angeles a height limit of 13 storeys is fixed for structures for residential or commercial purposes. It is suggested that this height limit be also adopted for Karachi.

Climate

The climate of Karachi—temperature, humidity, cloudiness, winds, precipitation and solar radiation—is shown by diagrams on the preceding two pages and overleaf. These diagrams are compiled from observations made over periods of 13 to 43 years, which data have been supplied by the Meteorological Department, Ministry of Communications. In this connection the “sensible temperature” is described. A “sun-path-diagram” for the latitude of Karachi is also given.

(a) Temperature

The annual temperature variations in Karachi are shown on page 21, which gives the mean value of the daily maxima and minima for each month. The diagram shows that the temperature rises from a minimum in January to a maximum in June, while the daily variation decreases. After a drop in July and August, the temperature reaches a secondary peak in October. The daily variation, on the other hand, rises steadily until it attains its maximum in the winter months.

(b) Humidity and Cloudiness

The annual variation of the relative humidity is shown on page 21. Karachi appears to have normal humidity for a coastal city, with high values during the summer months and somewhat lower ones in the winter.

This figure also shows the variations of cloudiness during the year.

(c) Winds

Winds at Karachi are illustrated by the "wind-rose" on the page opposite, which shows the relationship throughout the year between winds from different directions, and by the diagram on the same page, which shows the variation in the direction and strength of the winds on an average day for each month.

As the wind-rose and the diagram indicate, the monsoon blowing from west-south-west is the prevailing wind. In the summer months this wind dominates completely, and the greatest normal wind velocities, up to 20 m.p.h., occur in June and July. In the winter months the winds are somewhat more variable in direction. There are rather strong north winds in the forenoons and south-west or west-south-west winds in the afternoons. During this time the wind velocities generally vary from 5 to 10 m.p.h.

It is of interest to note that the wind practically never blows from two quarters of the compass, that is, from the east and south.

(d) Sensible Temperature

The above-mentioned three factors, temperature, humidity and winds, constitute what is called the sensible (or effective) temperature.

The temperature gives no direct indication of how the air feels to the body. Warm, moist air feels warmer than dry air of the same temperature, and wind has a cooling effect, except when the air is exceedingly hot.

The sensible temperature scale is an attempt to measure the combined effect of temperature, humidity and wind. Sensible temperature means the temperature of vapour-saturated air in slight movement (15 to 20 ft. per min.), which imparts the same sensation of warmth or cold as the actual air. For instance, if the temperature is 90°F on a day with slight wind movement but a relative humidity of only 30 per cent, the corresponding sensible temperature will be only 78°F. There are differences of opinion as to which temperature on this scale can be regarded as comfortable, but, as an example, two investigators—Yaglou and Drinker—give the zone of comfort as between 66° and 75°F in summer when one is at rest and clad in ordinary occidental clothing. The sensible temperature in Karachi, computed on the basis of the mean daily maxima for temperature, mean humidity, and mean wind velocities by months, appears to lie between 75° and 80°F from April to October, but in June it rises to 82°F. The

sensible temperature computed on this basis would be 64°F at its lowest point in January. On the whole the climate is not unfavourable in spite of the oppressive heat during the summer months.

(e) *Precipitation*

The mean annual rainfall in Karachi is 7.5 inches. The figure at the bottom of page 22 shows the precipitation during the year, giving mean monthly values and the maximum fall for a 24-hour period for each month. The maximum is computed for 24 hours from an observation at 8 a.m. to the next observation at this hour.

Precipitation at Karachi is light on the whole. Its uneven distribution is notable, since there is an average of only 9 days with rainfall in the year. The major part of the annual precipitation falls in June, July and August. The maximum fall recorded in June is not less than 800 per cent of the mean for this month.

(f) *Solar Radiation*

Solar radiation is abundant, and during the warm months often uncomfortably so. Fortunately, however, the maximum cloudiness also coincides partly with the period when radiation, if unshielded, would attain its highest intensity. On the page opposite is shown the path of the sun across the sky month by month and also the solar radiation upon a horizontal surface, calculated for each month. The values are reduced to allow for cloudiness. It has been calculated, however, that there is no heat radiation from an overcast sky. Since such radiation actually does take place to a certain extent, experiments having shown that 1/4 to 1/3 of the heat from the sun may penetrate an overcast sky, the indicated differences should be somewhat greater than the actual ones. The thick line in the diagram indicates values which might be regarded as probable in Karachi, pending investigation of the local conditions.

Vegetation

In arid and semi-arid regions the water policy is perhaps the most important practical problem which faces a community, a problem around which all the others revolve. The development of a community is limited by the supply of water, and the rational utilization of the available sources of supply is one of the major tasks to be accomplished.

On hilly ground the run-off will carry loose particles along with it. The smaller the particles, the more easily they are carried away. If the ground is bare on the surface, the erosive action becomes very considerable, reducing the capacity of the ground to absorb and retain the rain. Where this occurs it is, in most regions, the result of human mismanagement, but this state of affairs may be remedied and better conditions obtained.

To this end it is necessary to husband the existing resources of water and to work in agreement with the forces of nature. If this is to be achieved, the problem must be tackled from several ends, since one-sided measures will prove insufficient. In this connection it is suggested that the activities of the International Arid Zone Research Council of UNESCO should be closely followed by the respective Authorities.

(a) *The Object*

In so far as the region around Karachi is concerned the object is, in the first place, to obtain a rational utilization of the water supply so that it is possible to have some vegetation, at least in the immediate vicinity of the city.

From a climatic point of view the area must be regarded as semi-arid. The amount of rainfall is not so very small if calculated in absolute measures, but it is very uneven, there being a short rainy period and a long dry season, and, owing to the high temperature, the rate of evaporation is also very high.

The volume of water carried by the nullahs and rivers varies considerably. They are, on the whole, completely dried up during long periods of the year, although they occasionally carry considerable quantities of water during the rainy season. The ground is mostly bare on the surface and there is considerable erosion. The slopes and hills become increasingly destitute of fine soil and the watercourses become obstructed by sand banks in their lower course and by delta formations at their mouth. A further deterioration of the conditions regulating the natural utilization of the run-off must therefore be expected in the future, unless energetic measures to counteract this are adopted.

There are, on the other hand, certain practical possibilities for considerably ameliorating the situation, which may lead to an increase in vegetation in the area and, as a result, greatly improved conditions from many other points of view.

(b) *Surface Irrigation*

In order to improve the water supply of Karachi for domestic purposes, it has been proposed by the Municipal Authorities that water should be drawn from the Indus. It has also been suggested that the capacity of the canal leading from the Indus should be sufficiently great so as to allow a certain quantity of water to be used for surface irrigation. An investigation of this question is not included in the terms of reference of the Consulting Engineers and Architects. In this Report it should therefore only be emphasized that the quantity of water to be made available for irrigation merits careful consideration.

(c) *Underground Aqueducts*

In Iran, Afghanistan, Egypt and elsewhere water for irrigation is often obtained from underground aqueducts, so-called "qanats". These consist of tunnels in the ground which tap the ground water and carry it to low-lying areas where it is used for domestic purposes and irrigation. The aqueducts are too well known to warrant a detailed description here.

It is suggested that an investigation be carried out to ascertain whether underground aqueducts could be constructed with advantage in the surroundings of Karachi. It should, however, be borne in mind that the use of this method might result in a drying-out of land above the draining aqueduct. The method should therefore be applied with great caution in areas where the surface is cultivated and bears vegetation.

(d) *Kurum*

In Egypt, south-west of Alexandria, and in other parts of North Africa the Romans improved the water supply to their cultivation in the desert by building earth walls, the so-called "Kurum" (singular "Karm"). They were often constructed around the cultivated areas and were built 10 to 15 ft. high with sloping sides. When the rains came, the water ran rapidly off the flanks of the walls and augmented the water supply to the cultivated area within the kurum. Sometimes there was one single, straight karm only, in which case the vegetation was planted on each side along the karm. Dew falling on the karm will to some extent be absorbed by the ground and utilized by the vegetation. Kurum are still used in many parts of the world.

It is suggested that a few experimental kurum be built near Karachi to ascertain whether this method of augmenting the water supply would be an economical proposition. The idea might perhaps

be applied for supplementing the irrigation of park or garden areas by utilizing the precipitation falling on surrounding streets.

(e) *Measures to be taken regarding Watercourses*

Small dams should be built in series in order to retain the water as long as possible within the area where the rainfall has actually occurred. The object would be thereby to raise the ground water level and, in addition, to reduce the effect of erosion.

A full-scale realization of a project of this kind has been carried out in the State of Missouri, in the United States, where, in order to raise the ground-water level and reduce the effect of erosion and the fluctuations in the larger rivers, more than 10,000 small dams have been built every year since 1945. It is thought there that, within a period of 10 years, the programme will be almost fully realized, but even in the present stage appreciable advantages have been noted.

In the state of Nevada, where the annual rainfall averages the same as that at Karachi, similar methods have been tried with success.

It should be emphasized that the idea is to build a series of small and simple dams for the purpose of retaining water and preventing erosion. The dams should be built after a detailed examination of the country and preferably sited at a higher level than that where the nullahs are formed. Even small measures, at very reasonable cost, would imply certain improvements. It should be observed that the process is cumulative. Each pond will make the growth of a small amount of vegetation possible. This vegetation, in turn, will contribute to the retention of more water and thus cause more vegetation to grow, etc. Dew-fall will also contribute to this process. In due course the ponds will be filled with silt. In many cases the silt surface can be used for cultivation.

All the dams that are built must be fenced round in such a way that grazing cattle cannot reach and trample on the dams and slopes. In places where the water can, or should, be used for watering cattle, special watering troughs should be installed.

(f) *Suggestions regarding Soil Surface*

In order to achieve certain results steps must also be taken to protect and restore the soil. Large surfaces that now lie completely denuded and unprotected by any vegetation may be provided with a protective covering of plants. If the number of grazing cattle, sheep and goats is excessive, the covering of vegetation will be destroyed and erosion will set in. A vegetation which may be regarded as compact in relation to the natural resources may be used for grazing, but it must be kept in mind that overgrazing should be avoided. In the arid and semi-arid regions of the world, this is one of the most important problems.

If the vegetation of a given area is to be restored, it is not sufficient to reduce the amount of grazing. During a certain period this must be prevented altogether while, simultaneously, steps should be taken to improve the soil.

By growing suitable plants one should be able to obtain a protective covering of vegetation. There are sure to be plants that are suitable for the purpose, even if it may be necessary to test them locally in order to collect first-hand experience as regards their adaptability. Tests with the Kudzu, the leguminous plant of Eastern Asia, should be made as soon as possible as well as tests with *Opuntia ficus indica*, which might be used as a hedge.

The animals that must first of all be kept under control are goats. Owing to their frugality they can live on any kind of poor vegetation and, at the same time, they cause the worst instances of overgrazing.

The example of the restoration of the southern slopes of the Cevennes in France shows that, even in very seriously devastated areas with a small amount of rainfall, improvement is possible. Owing to the devastation of its forests and the subsequent grazing of sheep and goats, erosion had been considerable in this region. The layers of soil were to a large extent either carried away by the wind or washed away. About the year 1900 large areas were bought up by the Government, grazing was prohibited and re-forestation taken up. The slopes are now once more covered with forests and the water supply of the region is considerably improved.

It is impossible to predict that forests will grow around Karachi, but it should certainly be possible to produce a satisfactory growth of shrubs and to have the soil covered with a more or less compact vegetation consisting of low bushes and grass.

The importance of such a change for the better in the landscape surrounding Karachi is obvious.

CULTURAL BACKGROUND

“The main elements are the cell of the house, the centre of the bazaar and the spiritual focus of the Mosque. This trinity determines the town’s structure and plan. The streets are often directly oriented towards the bazaar; even the blind alleys open only to this side, hardly ever in the opposite direction.”

These three elements of a Muslim city, as described by E. A. Gutkind in “The Revolution of Environment,” correspond to three sociological groups, viz., the family, the neighbourhood group, or bazaar group, and the religious group, or Mosque group. These three types of groups will naturally change in character in the course of time. The interaction between the social development that this will represent and technical progress will be the theme of the Cultural Life of Pakistan. An expression of this theme will also be found in architecture and town planning.

In technical spheres the most far-reaching internationalization can today be observed. A motor-car, electrical equipment, cotton fabric or a pencil will be about the same in Pakistan as in any other country, and will be produced in about the same way. Leaving aside the variations which are dependent on geographical conditions—for instance on climate—technical structure can, on the whole, be said to be similar in character wherever industry occupies a prominent position in the life of a country.

In cultural life, in a limited sense, however, there are spheres where regional or local factors are predominant, and difficulties arise in realizing their relation to the lay-out of a city. The way in which people feel towards each other and the way they gather in social groups, are, owing to tradition and social customs, of the utmost importance for the structure of the community and for the building of their cities. In the Islamic community there are mainly three social groups of importance for the planning of the city—the religious group, or Mosque group, the neighbourhood group, or bazaar group, and the family.

The Religious Group

Islam—“God’s will be done”—is the faith of Pakistan. Today, religion and nation are indivisible, the nation being a large religious group, centred in the Capital, the heart of Pakistan, and its Mosque. This large group is built up of smaller religious groups centred in other Mosques and particularly in the Jami Masjid, the Mosque of Friday Prayers.

In Muslim cities the Mosque does not always present a striking element in the general picture; it frequently lies near the market place and the bazaar, mingled with the rest of the buildings. It is often impossible to walk around the Mosque, and all that can be seen from the street are the large entrance doors. No wall is apparent and the boundaries of this important building are not clearly defined, since it generally forms one compound with its surroundings. What is thus sometimes lost by lack of a visible boundary is gained in functional expressiveness: the Mosque is the focus of the city. On the large open court of the Mosque much of the life of the cities is centred.

Whether or not the Mosque has a magnificent outward appearance, it always manifests seclusion from the outer world and concentration to the inner world.

It would appear advisable that the Mosques should not only be located in the Neighbourhood Centres, but that an attempt should be made to follow the Islamic tradition, mentioned above, with the Mosque, though a focus of a part of the city, mingled with the other buildings around it. The Master Plan, on the other hand, assumes that a Mosque of magnificence and beauty, visible from afar, should be built at the “Forum of the Nation” in the Capital or at the tomb of Quaid-i-Azam.

The Neighbourhood or Bazaar Group

The bazaars are also centres of a Muslim city. The bazaar and the bazaar area, no less than the Mosque, present a natural meeting-place, where news passes from mouth to mouth and where opinions are formed against the background of the buying and selling of merchandise. Here is the centre of the city or the neighbourhood, from here the throb of life is passed on to its most distant streets and alleys. All that side of life external to the home—which, to a large extent, is the life of men—is concentrated here. It is natural that the bazaar should have acquired this prominent place in the life of the cities, since the handling of merchandise has for centuries been the most important city-forming occupation. In the future the bazaars and the commercial centres will probably retain at least a part of their position as social centres, even in an industrialized city, and thus form a social group around themselves.

As the town grows and ways of production and distribution alter, the old bazaar may not be able to keep together more than a small part of the population as a socially gathered group. The rest will either be living too far away from it or will not have such an intimate personal contact with the bazaar as to be socially bound to it. Industrialization will play a formidable role in this breaking of social bonds. In industrialized communities in the West non-personal contacts tend to predominate, resulting in a slackening of the interest in upholding the spirit of the community and common responsibility within a certain neighbourhood. As interest fades in cultural values and institutions, the social bonds within the neighbourhood become broken.

This breaking away from the local group must be regarded as undesirable, but it need not necessarily be repeated in Pakistan where industrialization can begin at a time when its effects on the life of the community and of the family have already been recognized. Pakistan may now create a community which need not suffer from the growing pains of industrialization. If, unlike the culture of the secularized West, where technical achievement is the principal platform for the competition of groups and individuals, the culture of Pakistan is a sociable and unitary culture, it may be possible for the local urban group to instil into the life of the individual a stability and a spirit of community.

To meet this situation a division of the new parts of the town into Neighbourhood Units is provided for in the Master Plan. They should be clearly separated from each other and should be self-containing in most respects. This idea is also complemented by proposals to build different kinds of centres, such as Residential Centres, Neighbourhood Centres and District Centres. It is quite obvious that these measures will not guarantee the effect desired, but they might prove helpful to achieve this end.

The Family

The traditional type of family in Pakistan is the undivided, large family which forms a household where more than two generations—perhaps as many as four—live under one roof. An important trait is that the property is mainly owned jointly, and economic activities are often undertaken by the household as a group. This applies pre-eminently to the agricultural household of the village community and still prevails in craftsmen's households.

In an industrialized city community, livelihood will be earned by work in factories and offices, and the family group and the family house will be deprived of one of its main functions. The migration of the population—a feature of the progress of industrialization—will also further disintegrate the large family.

The lay-out of a house depends on the size and composition of the family living in it, but other factors also play their part. Thus, for instance, the inhabitant of an eastern country does not in general

regard a house in the same light as the European. In Europe, the rooms of a house are divided according to activities into separate units, such as the living-room, the bedroom and the kitchen. In the East, on account of the marked variations in the temperature of the rooms, a householder arranges his house in such a way that he can inhabit different parts of it during different parts of the year and during different hours over the twenty-four-hour day. Since, in the East, people are not dependent on the whole conglomeration of western furniture and fittings, it is easy for them to assign one room to different purposes and they do not set it apart for some particular use. This simplifies life.

In the Muslim dwelling the most important social division is the one connected with the institution of purdah. Part of the house is reserved for the family only, and this is the setting for the women's work in their home; in another part of the house the men receive their guests.

A well-to-do family can afford to have groups of buildings around two separate courts, one for the men and one for the women, while a family whose resources are limited has to arrange the entrances and doors of its house in such a way that the largest possible part of the house can be secluded from visitors.

The changes in the life of the people, which will be caused by a gradual industrialization, will exert their influence on the future type of dwellings. Town-planning should take into account that a disintegration of the large families will lead to an increased demand for more but smaller houses or for flats.

The institution of purdah may be expected to become more rare as families become smaller, the number of women workers increases and a higher educational status among women becomes usual. This will have far-reaching effects on the lay-out of the dwelling house and the residential areas. It should be possible to open the house to the street, which may, *inter alla*, lead to improved lighting and cross-ventilation. In addition, the idea of renting a flat will probably become more acceptable, which will make it possible to arrive at greater concentration in certain parts of the town without abandoning the social requirements connected with the layout of residences. This will be a definite advantage in a large city with its otherwise very extensive network of communications.

The City

In every process of creation there is the will to create a specific form; the desire may be conscious or unconscious, strong or weak. The onlooker is affected by form; it gives him ideas or impressions which are more or less valuable. In the sphere of town-planning—as in most of the fields covered by architecture—form does not only imply space, surface and colour; in this sphere the rhythm of the life of the streets, squares, and houses, the speed of motor-cars and the calm atmosphere of a park must also play their role. A city is not merely the background of the play, it plays a certain part in deciding what is going to be staged and how it will affect the onlooker who is also taking part in the performance. The lay-out of a city has often served for the glorification of a ruler and for the staging of pageants meant to suggest to his subjects an idea of his greatness. In a democratic community it is the duty of the town planner to balance the form to be given to the different elements of which a city is composed, so that they, together, form a whole, rich in contrasts, full of excitement, varied and interesting. A city must express both the requirements and wishes of the individual and those of the social groups; it must provide for and emphasize the peaceful life in a residential area, the productive co-operation in the place of employment, the swarming life in the bazaar, the "joie de vivre" in the community centre and the ideological tension in the large meeting places.

Cities or city areas may contain the above elements and yet be cast in different moulds. Certain patterns of lay-outs have often been predominant at certain times and typical of a certain civilization while, on the other hand, different patterns have been simultaneously used within the same

civilization. Far-reaching conclusions can be drawn from examples of a special type only after studying the local and historical conditions in every particular case. Some types are almost universal, as, for instance, the type of lay-out which is characterized by one or two main axes—the latter crossing each other at right angles—with a built-up centre, connected to the axes, which may contain a citadel, a place for divine worship, a bazaar and a square for public gatherings. The Greek cities of antiquity were often laid out in this way, and Tenochtitlan, the Aztec city in Mexico, and Peking in China, have followed such a pattern. The same arrangement recurs in the cities of the Roman Legions. Another universal pattern is characterized by a big open space, a "maydan", surrounded by the principal buildings of the city. Such a city focus is common in ancient Greece; we see it in Macchu Picchu, the Inca city in the Andes of South America, and in many Italian cities, e.g. Pisa, Sienna and Venice. Perhaps the most affecting and beautiful examples of this pattern may be seen in Muslim cities such as Isfahan.

Geometrical regularity in the lay-out of a city may be the expression of some authoritative power during the building of the city. The power may have been vested in a single person, in a governing class, or in a government appointed democratically. This regularity thus may express the wish of a ruler or of a leading group to demonstrate their power, but it may prove besides their lack of interest in the living conditions of the population. The city might have been forced to adopt such geometrical plans although their suitability from a functional and social point of view had not been considered. However, the regularity of the lay-out of a city may just as easily be the expression of the tradition of a stabilized community in its effort to instal order—an order which has, so to speak, entered into the blood of the individual.

A study of the early history of town-planning may therefore be of interest, in spite of the fact that no earlier or contemporary civilization can provide a pattern that could be completely applied to a city in such a technical, social and cultural evolution as is imminent in Pakistan. In particular, the more or less feudal structure of the older Muslim cities cannot serve as a readymade pattern to be transplanted to the cities of the Pakistan of the future, where the life of the community will be quite different. The elements of different forms of lay-out, obtained from various sources, will have to be blended with each other and with newly-created elements to form a whole which, in time, may become significant for the modes of living particular to Pakistan.

In as far as the social structure of the older cities survives, and may be expected to go on surviving, certain of the elements which go to form a city could nevertheless be planned on the old basis; this refers, for instance, to the siting of a Mosque, the arranging of a square or of a bazaar area. In the Islamic world there can be seen examples of towns focused on the maydan and the Mosque where these two elements give a simple, almost abstract expression of the spiritual unity of the population. The rest of the town is left for development in a free form and is subject to individual influence which expresses the practical requirements of the population. Reference may be made to the magnificent Maydan-i-Shah and its surroundings in Isfahan. Here, clothed in a grandiose architectural form, we find the element which has been significant of Islamic architecture throughout the centuries—the enclosed room, an expression of introversion.

Karachi of today

Karachi as it exists today is not a typical Muslim city and does not contain any outstanding examples of Islamic architecture. The town as such has only existed for about two hundred years and had no great importance before the British, about 100 years ago, founded a port there for ocean-going ships and extended the railway to the Punjab in the 1870s. Until Karachi became the federal capital of Pakistan in 1947, it was for many years the capital of the Province of Sind. Previously Thatta was the most important city of the region. Before Partition the town had a very mixed population in which the Mulims formed a minority only.

The most striking aspect of the city's lay-out is Bandar Road which, starting from the port, runs straight in a north-easterly direction right through the centre of the city. It is the town's main artery.

Near the port and on the north-west side of Bandar Road lies the old town, an irregularly shaped part of the city with multi-storey buildings and narrow winding streets and alleys, partly used as bazaars. This is the oldest quarter of the town, and is reminiscent in character of a mediaeval town in the Near East or Europe.

Two miles east of the old town is the cantonment, and in continuation of this, are the residential quarters of the civil servants, the Civil Lines. These are noted for their well-constructed bungalows, hotels and clubs set out in large, well-kept gardens, arranged in a rectangular lay-out of wide streets; the whole area has the spaciousness characteristic of the European sections of Indian towns of that period. Close by the Cantonment and Civil Lines stands the Saddar Bazaar—a business area in chessboard form, with some multi-storey houses, which retains its position as an important shopping centre.

In the course of time, the area between the old town and the cantonment, and north-west of the Cantonment, has been laid out in blocks of a more or less regular nature. Multi-storey houses were built mainly in the western parts, bungalows in the north. No attempts were made to carry out deliberate planning on a larger scale, except within the area west of the Cantonment, where the provincial Government for Sind had its location.

Areas of interest outside the city boundary are the agricultural village of Malir, to the east, and Mangho Pir, the old place of pilgrimage by the hot spring, to the north of the town.

CHAPTER III

POPULATION AND OCCUPATION

The standard of living of the people of Pakistan will rise considerably during coming decades. This will be the result of an increase in production and a decrease in birth-rate; the volume of production will grow much more rapidly than the population. Births and deaths do not seem likely to balance until the year 2000. By that time the population of Pakistan is estimated to have increased from the present 75 million to about 100 million people.

Although agriculture will remain the basis of Pakistan's production, fewer people will work in the fields and increasingly more people will be engaged in industry and trade, and in the scientific and educational professions. A similar trend can be observed all over the world, causing a concentration of the population to the towns and especially to certain large centres in each country. The rate of this development has, to a large extent, been dependent on the supply of capital funds.

The problem of estimating the future size of Karachi has been approached in different ways. All the results indicate a possibility of a growth so rapid that the number of inhabitants may pass the figure of three million within the next 50 years.

On the basis of comparisons with cities of a similar character as the future Karachi, the following probable distribution of the population has been arrived at:

Production proper	..	..	40 per cent
Transport	..	..	15 " "
Trade	..	..	25 " "
Public administration	..	..	20 " "
			<hr/>
			100 per cent

It is more or less impossible to prepare a functional and economic town plan without having a rather definite conception of the future size and composition of Karachi. The further one looks into the future, the more difficult it is, however, to make an accurate forecast. It is naturally out of the question to give in this Report a definite opinion as to Karachi's future development. Nor is this, for various reasons, necessary for the practical town planning of the city. The future inhabitants will probably be able to provide for their material requirements more efficiently than the present population. It would therefore be unreasonable to demand that the present population should sacrifice certain of their present-day requirements for the sake of arrangements intended to benefit Karachi's population in a remote future. In view of the uncertainty of our knowledge even of the near future, it is important to make the Plan flexible and to give free scope for developments in as many respects as possible. Such a flexibility may, as a rule, be achieved without appreciable costs merely by means of careful town-planning and land reservations. It would therefore be practical to restrict specific forecasts for the future to the next 50 years. It should, however, be borne in mind that, although 50 years are specified for the period of time to be covered by the arrangements here proposed, the actual time for the same development might be anything between, say, 35 and 70 years. The figure of 50 years is used only as a concrete expression and to avoid a repetition of the phrase "say between 35 and 70 years". The only possible method of preparing a forecast for the next 50 years appears to be—

(1) to study the conditions of the country of which Karachi forms an important part, and

- (2) to study the development and the conditions of cities in other countries which have already passed Pakistan's present stage of development but which, in other respects, are similar to Karachi and Pakistan.

Due to the fact that the following investigations are made only for the purpose of estimating Karachi's future development, any factors which do not relate to this particular aspect will not be dealt with.

Pakistan

Economic Life and Population of Pakistan with special regard to Karachi

Up to the present, Pakistan has been a typical agricultural country the national economy of which has almost entirely been based on the principle of self-sufficiency. Its resources of arable land, about 0.6 acres per head of population, and the working capacity of its people have been generally sufficient to satisfy requirements as to food and clothing, although, on several occasions, famines have nevertheless occurred. In the future, Pakistan's arable land will probably remain one of the country's most important natural resources and its agricultural produce the chief means of barter in international trade. The most important foodstuffs grown have so far consisted of rice, wheat and millet, while the cotton and jute produced have met the demand for textiles and formed the country's chief exports. These exports are of very great significance, since they make possible the import of minerals, fuel, and other raw materials which are scarce in Pakistan.

When a census was taken in 1941, the area which forms the Dominion of Pakistan had a population of 70,330,000 (equalling 3 per cent of the world's population on 0.6 per cent of the world's total land area) of which 28.3 million lived in the present West Pakistan, and 42 million in East Pakistan. Preliminary reports of the 1951 census give a total population of 75,687,000 in Pakistan, of which about 33.5 million live in West Pakistan. The density of the population in the different parts of West Pakistan varies considerably. In 1941 the Western Punjab was almost as densely populated as the State of New York, and the North-West Frontier Province followed closely with a population whose density exceeded that of France. The density of the population of East Pakistan exceeds that of England and the Netherlands, which are the most densely populated areas of Europe.

Since 1941 there have been marked movements of population. According to the 1951 census East Pakistan appears to have an excess of 5 million emigrants over immigrants and West Pakistan an excess of between 1.5 and 2 million immigrants over emigrants.

The total population of Pakistan is larger than that of any other Muslim country and the largest but one of all the Realms of the British Commonwealth. The differentiation of the population, according to the census taken in 1931, is shown in the figure opposite. This diagram may be compared with the corresponding diagrams regarding the population of Sweden (the first country to introduce population statistics) in 1750 and 1940. Conditions in Sweden in 1940 were very much the same as those in England and the U. S. A.

With the help of the available statistical data of the census it is possible to calculate that, in 1941, about 30 per cent of West Pakistan's and slightly less than 20 per cent of East Pakistan's population were employed in so-called "city-forming" branches of occupation, i.e. they supported themselves principally by *local* production, the rest living exclusively by *areal* production. "Areal production" is the term given to types of production which are directly dependent on the size of the area utilized. Thus the census group concerned with "exploitation of animals and vegetation" is assigned to areal production. "Local production," on the other hand, is the term given to types of production which are concentrated to certain localities the size of which is of minor importance in relation to the volume

of output. Such production includes trades dealing with "preparation and supply of materials" and also "public administration" and "public service". Thus it may be said that the local production is concentrated to specific localities whereas the areal production is spread over wide areas.

The distribution of the population living on local production over localities of varying size is of interest for estimating the development of Karachi. In many countries this distribution can be described as more or less following a statistic law which the German geographer, F. Auerbach, was the first to observe (see an article on "Das Gesetz der Bevölkerungs-konzentration" in Petermann's "Mitteilungen", Gotha, 1913). He discovered that the number of inhabitants in the largest cities of a country were approximately in inverse proportion to the numbers 1 : 2 : 3 : 4 : 5, etc. This is practically the case in Egypt, Japan, Sweden, Switzerland, the U. S. A. and, as far as is known, in China and the Soviet Union. It does not apply to England, where London is very oversized in relation to Birmingham and Glasgow, due to the fact that London is not only the capital of England but is also the centre of the British Commonwealth and thus an enormous trade passes through it. Furthermore, it does not apply to France, Paris being, for similar reasons, considerably oversized in relation to Marseilles and Lyon. Nor does it apply to Italy, where Rome is undersized in relation to Milan and Naples, because Rome is not a trade centre. In the Netherlands the largest city, Amsterdam, is undersized because it is not the capital. In Spain, Madrid is undersized in relation to Barcelona because Madrid lies inland, has no port and is not the centre of commerce. It can be seen that, in those countries where the Auerbach rule does not hold good, obvious reasons can be given for the deviations. For the present it is not possible to foresee any reason for Pakistan to deviate from the general law. Therefore, Auerbach's rule may reasonably be applied to the Pakistan of the future and used as a corroborative argument when estimating the growth of Karachi. A satisfactory survey of the distribution may be obtained by ranging densely populated towns according to their size in groups in a geometrical series; in this case groups having limits of 100, 320, 1,000, 3,200, 10,000, 32,000, 100,000, 320,000 and 1,000,000 inhabitants are chosen, the ratio of the geometrical series being $\sqrt[10]{10}$. If the above-mentioned law holds good, all such groups show approximately the same total number of inhabitants. If, in West Pakistan, the population dependent on local production only is taken into consideration, it appears that this population, on the whole, is distributed according to Auerbach's law, but the agricultural population shows quite different distribution, the group comprising about one thousand inhabitants being very predominant. Both these distributions are illustrated in the figures opposite.

According to the census taken in 1931, 44 per cent of the population of the entire subcontinent were engaged in some occupation—36 per cent in the capacity of earners and 8 per cent as working dependents. Earlier censuses show slightly higher figures, but even the figure for 1931 is remarkably high in view of the large number of children and the almost negligible number of unmarried, adult women.

Future Development of Pakistan's Population

The statistics at present available for the entire subcontinent are not sufficient for such estimates of the future population as are usually made in connection with town and regional planning. It is naturally of the greatest significance for future developments that such statistics should be compiled, so that the planning institutions may be kept completely up to date in regard to any changes in the population.

In spite of the insufficiency of vital statistics, however, an estimate of some kind must be made in order to plan the future city. To make a forecast based on an assumed rate of births and deaths appears to be the best approach to the problem.

According to the data contained in the India-Pakistan Year Book for 1949 the death-rate was about 24 per thousand per annum, on an average, between 1920 and 1940. Sweden had the same death-rate figure during the decades immediately preceding and following the year 1800. Although in

both cases there are great divergences for the different years, a certain trend towards a decrease in the death-rate may be noticed in Pakistan; this corresponds approximately to the decrease in the death-rate in Sweden at the beginning of the 19th century.

The data given in the Year Book indicate that, between 1920 and 1940, the birth-rate increased slowly, and lay between the extremes of 32 and 36 per thousand per annum. These figures also correspond to the situation in Sweden about the year 1800. Some population experts consider that the figures given are too low. In "Population of India and Pakistan" (Princeton, N. Y., 1951) Kingsley Davis mentions a death-rate of 30 to 35 per thousand per annum and a birth-rate of up to 45. The difference between the birth-rate and death-rate figures being substantially the same whether the Year Book figures or Kingsley Davis's figures are accepted, the two pairs of figures will give the same result with reference to the estimated future increase in population.

After 1940 a trend towards a falling birth-rate has been recorded on the subcontinent, but the birth-rate is still very high. Since the death-rate is falling as a consequence of the development of medical services, a rapid increase in the total population would result, provided that the birth-rate does not fall rapidly. This matter is of significant importance for development within Pakistan. Should a decrease in the excess of births over deaths actually occur, this would, for the first time in history, give reason to hope that the constantly recurring famines will definitely be averted, and would provide a guarantee that the efforts being made to increase the yield of the crops will actually lead to improved living conditions for the population. It is true that at earlier periods the population of the areas forming Pakistan was temporarily stabilized, for instance between 1901 and 1921, but this stabilization would seem to have been due to an enormously high death-rate counterbalancing the number of births, which probably was high even at that period.

Assuming that births and deaths will balance about the year 2000, the population of Pakistan will increase from about 75 million in 1951 to about 100 million at that time. It has also been assumed that about 45 million thereof will live in West Pakistan and about 55 million in East Pakistan, which corresponds to the proportion existing after the migration of the refugees. The distribution of the produce of the country among 100 million people implies that each person will receive less than if the same produce were divided among 75 million; this will be felt even more keenly in the future, when there will be a larger proportion of adults. Since, however, there are still reserves of cultivable soil and since, in Europe and America, it has been found possible in some parts to increase the yield per acre to a level which is more than twice as high as the yield at present obtained in Pakistan, it should nevertheless be possible to look forward to a considerably higher standard of living, even if the population should reach the figures mentioned above.

Irrespective of the size of the population, it is clear that the necessary agricultural work can be carried out by employing far less labour than at present. In Canada, where the yield of wheat per acre usually equals that obtained in Pakistan, the labour required per acre is less than one-tenth of that used in Pakistan. It only remains to calculate the speed with which the necessary transfer of labour from agriculture to industry and other city occupations will be accomplished. This speed varies between the different countries, and in Pakistan changes in this direction have hitherto been very small and have only counterbalanced the earlier changes in the opposite direction. The United States is one of the countries where the population dependent on local production has increased most rapidly. If it is assumed that in West Pakistan future developments are likely to keep pace with those observed in the United States during the latter half of the 19th century, then the "city-forming" population of West Pakistan dependent on local production might increase from 30 to 55 per cent of the total population, between 1940 and 2000. This is, of course, a very rough estimate made with regard to the future development of Karachi only.

A combined calculation, on the above lines, of the estimated total population and the percentage of the population dependent on local production shows that in the year 2000 West Pakistan may have a population of about 25 million people engaged in urban occupations, as compared to slightly over 8 million in 1941. The possibility of a further increase after that date is not excluded, since even countries exporting agricultural produce may have a high percentage of the population engaged in urban occupations. It is, however, doubtful whether both the total population and the percentage of persons employed in urban occupations will develop according to such estimates. On the one hand, an increase in the population of such areas that are, to some extent, already overpopulated may check the process of industrialization. On the other hand, a rapid change-over to occupations based on local production may entail a more rapid decrease in the birth-rate, resulting in a less pronounced increase, or perhaps a decrease, in the population. Since, in the present case, plans are to be made for the urban population, calculations should be overestimated rather than underestimated.

Future Production, Consumption and Trade of Pakistan

The predicted development outlined in the foregoing paragraphs rests on the assumption that, owing to increased production, the standard of living in Pakistan will have considerably improved. Since, however, the requirements of consumers with a high standard of living will not coincide with the kind of production which is natural for the country, it will be necessary to organize a more intensive exchange of commodities. Pakistan must naturally count on a considerable increase in the consumption of foodstuffs and the demand for textiles, but there will first be an increased demand for such commodities as transport vehicles, books and newspapers, sanitary equipment, household furniture, etc. Most of the latter commodities will either have to be imported direct from abroad or, using imported fuel and machinery, manufactured from imported raw materials. In order to pay for these imports the country must export agricultural produce, such as foodstuffs, jute and cotton, to a hitherto unknown extent. Since the countries adjacent to Pakistan can hardly be expected to produce sufficient quantities of the goods Pakistan will need, much of this trade will have to be trans-oceanic.

In order both to provide the country with more foodstuffs and textiles and to supply it with the means for obtaining other commodities, agricultural production must be increased until it reaches perhaps several times its present value. This may partly be accomplished by irrigation and by cultivating new areas. Such an extension of the arable land by 6 million acres, or 13 per cent, is proposed in the Six-Year Development Plan of 1950. In the first place, however, improved agricultural methods will have to be adopted and the soil will have to be exploited more intensively. Certain European countries have been able to obtain considerably larger crops by using improved seed-corn, fertilizers and insecticides, and, in some places, by deeper ploughing using mechanical ploughs. These or similar measures will also further the development of agriculture in Pakistan, assuming that the work is carried out by scientific methods and that the necessary materials and machinery are imported, and this, in itself, will further increase the volume of trade.

As can be seen from the table below, the value of foreign trade per head of population has hitherto been insignificant on the Indo-Pakistan subcontinent. Even in countries possessing a variety of natural resources, and self-supporting in several respects, the value of foreign trade per head is much higher. On the whole it might be said that the proportion of a country's production that is exported increases more rapidly than its total production, since, in countries where the standard of living is high, the percentage of exports is generally also high.

Table—Comparison of the value of foreign trade per head of population in different countries in 1938

The mean of exports and imports is given in rupees and refers to the price level in 1938.]

(According to "Statistisk årsbok för Sverige, 1950", Table 332, arranged by "Statistisk Sentralbyrå", Oslo).¹

Indian Empire	..	4	Chile	..	80
Soviet Union	..	4	Germany	..	90
Indonesia	..	14	Union of South Africa	..	140
Mexico	..	20	Finland	..	150
Brazil	..	20	Ireland	..	160
Poland (incl. Danzig)	..	20	Great Britain	..	200
Portugal	..	30	Canada	..	200
Egypt	..	30	Sweden	..	230
Japan	..	30	Commonwealth of Australia	..	230
Italy	..	40	Switzerland	..	240
Hungary	..	45	Norway	..	250
Greece	..	50	Denmark	..	270
U. S. A.	..	55	New Zealand	..	400
France	..	80			

According to data given in the Six-Year Development Plan the foreign trade of Pakistan in 1949 amounted to about 6 per cent of the national income, which is calculated at Rs. 215 per head of population. A rise in the standard of living, corresponding to the assumed increase in urban occupations, would perhaps imply a fivefold increase of the present figure by the year 2000. This corresponds to an increase in income of 20 to 25 per cent per head every six years, or about the same as the actual goal of the Six-Year Development Plan. Pakistan would then be able to achieve a production per head which would be comparable to Italy's production before the war, when that country exported roughly ten times as much per head as Pakistan did in 1949, and the value of the goods which annually crossed the frontiers of Italy (population 43 million) amounted to 3,500 million Rs. (1938 value). If the average value per ton is estimated at Rs. 100 (Swedish figure, 1938 value), this would mean that in 1938 the total volume of Italian foreign trade imports and exports amounted to something like 30 or 40 million tons. The value per ton of goods handled in the Port of Karachi before the war was Rs. 270. In the future, Pakistan will also have to import goods of lower value, such as iron and coal, and the exported commodities will perhaps include other and cheaper agricultural products than cotton and hides. For this reason the future Pakistan trade will probably consist of goods with approximately the same value per ton as in the West. This implies that the volume of trade in tons to and from West Pakistan, with her future population of 40 million, will increase almost to that of Italy, or, say, to 25 million tons. It is true that there are countries with a somewhat lower standard of living than Italy, for instance, Greece and Chile, which have a more extensive foreign trade. But it is also a fact that, in West Pakistan, among other factors, geographical conditions (viz. the long routes and the costly manner of transport by land) will remain as obstacles to expanding foreign trade.

The predicted future volume of trade, i.e. about 25 million tons per annum, is, in any case, based on the assumption that river transport is utilized as well as transport by rail. Even in Western Europe and the U. S. A. transport by river and canal plays an important part. The cost of such transport per ton-mile should amount to one-third at most of the cost of transport by rail. Although no allowance

¹ Statistisk årsbok = Statistical Year Book.
Statistisk Sentralbyrå = Central Bureau of Statistics.

is made on the waterways for a draught exceeding 9 or 10 feet, barges loaded with 1,000 and even up to 3,000 tons may be used on them, the latter amount being 3 to 5 times as much as a goods train will carry. With such large units it might be possible to reduce the cost even below the figure mentioned above. The fact that, in certain cases, river transport may be possible only at high water does not present any unsurmountable obstacle. In other parts of the world, goods are transported by sea although the shipping season is exceedingly short (i.e. three months and less in the White Sea and Hudson Bay) due to ice formation.

Karachi

Karachi, its Situation, Origin and Past Development

Karachi is situated at the delta of the Indus River in the western part of Sind about 500 miles from the most densely populated centre of West Pakistan and its vital agricultural area in the Punjab. The distance from Karachi to East Pakistan is about 1,400 miles by air, and almost twice as much by sea. The sea route is equivalent to the length of the Mediterranean or the smallest width of the North Atlantic. In view of the low cost of maritime transport the freights between Chittagong, the most important seaport of East Pakistan, and Karachi may be appreciably lower than the freights between the northern part of West Punjab and Karachi, provided that only land transport is used on the latter route, see figure on page 53.

Agriculturally, the Karachi district is one of the poorest in Sind, the city owing its growth and present importance exclusively to its harbour.

Karachi seems to have been used as a port from about 1700, probably in connection with fishing, but no town appears to have existed before 1725. In 1795 the Mirs of Sind gained Karachi from the Khan of Kalat and erected a permanent fort on the rocky point of Manora, which screens the port from the sea. In 1836 the city was occupied by the English, and in 1842 it was ceded to the British Government. At this time it is said to have had a population of 14,000. When the North-Western Railway was built in 1878, Karachi became the terminus of the entire broadgauge railway network of the provinces now forming West Pakistan. Karachi is now connected to West Punjab by means of a double-track railway, the capacity of which probably exceeds the present demand. The entire foreign trade of West Pakistan, with the exception of the trade with adjacent countries, passes through Karachi, and it is significant (as an indication of the trend before Partition) that Karachi registered large increases in the receipt of goods from both the United Provinces and Rajputana. Karachi is also the nearest port for the export trade of Afghanistan, Rajputana and Kashmir. During the last few decades the city has become one of the most important junctions for the air traffic between Asia and Europe. For many years Karachi was the capital of the Province of Sind, and after the independence of Pakistan was declared in 1947, the city became the Federal Capital.

The increase in the population of Karachi up to 1951 is set out in the figures opposite, and this also provides a comparison with certain other towns in Pakistan and on the subcontinent. On the whole, the development of the city up to 1941 corresponds to the typical development of large cities all over the world. The rate at which it has grown has certainly varied considerably, but this has happened in most cities and may be regarded as a normal process. The average rate of its growth was 3.0 per cent per annum between 1881 and 1941 and about 4.2 per cent per annum between 1843 and 1881. During the 1930s the largest increase ever encountered until then, amounting to an average of 4.6 per cent per annum, was registered. Since then, owing to events connected with the Partition, Karachi has had to absorb large quantities of refugees and in the course of recent years its population has increased more markedly than ever before and reached 1,118,000 in March 1951. Economic developments, however, have not kept pace with the influx of refugees, and as a consequence the proportion of the

working population to those not employed in any specified occupation has, to a certain extent, become disturbed.

Nothing short of a census of the type taken at ten-year intervals between 1881 and 1941 can give a clear idea of the present scope of the city's economic life and of the number of people engaged in different trades. Unfortunately, only a very small part of the data classified by the census of 1941 could be obtained; the most recent data regarding the economic life of Karachi given here therefore refer to 1931. At that time 5 % of the working population of Karachi were engaged in occupations classified in the census as "exploitation of animals and vegetation", 21 % in "industry" and "mineral production", 13 % in "transport", 23 % in "insufficiently described occupations" (most of which probably in reality belonged to industry and transport), 19 % in "trade", 7 % in "public force," 5 % in "public administration", and 7 % belonged to the group "professions and liberal arts". The above differentiation is made without taking into account the groups "domestic service" and "unproductive occupations". According to the same report 34 % of the total number of inhabitants belonged to the working population (including those in "unproductive occupations"), a proportion considerably lower than the 44 % regarded as normal on the Indo-Pakistan subcontinent. However, the percentage of the working population varied greatly in the different cities, thus Hyderabad in the Deccan had a working population of 62 %. The proportion of women workers varied between 3 % and 38 % in different cities and was 9 % in Karachi.

Probable Future Size of Karachi

The size of the population of a big city usually depends, primarily, on the functions of the city in relation to the economic life of the country. Karachi has a twofold function to fulfil, since it represents:

- (i) The seaport of West Pakistan, where practically all foreign trade and all trade with East Pakistan is handled and which is therefore best suited for the location of certain industries.
- (ii) The Federal Capital and, consequently, the centre of culture for the whole of Pakistan.

Either of these functions may be assumed to require a population that bears a relation to the number of inhabitants in the hinterland, in this case to the population of West Pakistan or of Pakistan as a whole.

Although only a comparatively small number of people are necessary for carrying out the work required in a port, seaports are often large cities. This is due to the fact that the work directly connected with the loading and unloading of ships is practically never the only kind of work assigned to a port. Experience has shown that it is, as a rule, expedient that all the activities connected with the transport of goods be concentrated in one place. In many cases it has also been found advantageous, when transferring goods from one means of transport to another, to complete part of the finishing process which the goods may require. Thus, the handling of goods at a port consists of, *inter alia*, storing, sorting, grading, classifying, valuing, distribution and packing. To these must be added various kinds of administrative work, commercial correspondence, advertising, insurance and banking. The last-mentioned activities play a not inconsiderable part in increasing the number of travellers and thus in creating a greater demand for hotels, restaurants and other services as well as for public transportation. The finishing processes applied at a seaport to imported goods may be of very great significance as regards the total man-power required. This processing work becomes particularly important when imported fuel is used for treating imported or exported goods; in such cases it would be uneconomical to transport the fuel further inland. For these reasons it is to be assumed that Karachi will be the best place for the location of cement work, oil refineries, etc. The mounting of the rolling stock for West Pakistan's broad-gauge railways is another example of the work which might profitably be carried out in Karachi, since it is advantageous both that such material is imported unfinished and transported

further inland by its own locomotion. Karachi will also be the most suitable place for industries which require to maintain a close personal contact with foreign importers, exporters, manufacturers of machinery and others. For these or similar reasons many of the textile industries working for export may have to be located at Karachi. In addition, Karachi is the most suitable place for shipbuilding and for large-scale canning of fish for West Pakistan.

To calculate the population which would be required for the occupations described above, which are specific to seaports, comparison must be made with corresponding conditions in other countries. To begin with, it seems natural to compare Karachi with seaports having a trade turnover corresponding to the trade that Karachi is expected to attain in the future. Since almost the entire foreign trade of West Pakistan has to pass through Karachi, quantities reaching about 25 million tons per year may, according to the above considerations, be anticipated. Before the Second World War the turnover of two European seaports reached that figure, viz. Hamburg and Antwerp, the two largest ports after London and Rotterdam. Hamburg had a population of 1.7 million and Antwerp (including its suburbs) had about 0.5 million. The difference in population is too large for making an estimate directly based on these figures. Another method would be to make a comparison with the total population of seaports in countries whose geographical conditions and requirements in the way of ports correspond approximately to those of West Pakistan in the future. The first consideration strictly limits the possibility of making comparisons, since the most densely populated areas of countries with an outlet to the sea seldom lie far inland. Thus the densely populated areas of western countries do not lie at such distances from their ports as they do in West Pakistan. Certain similarities are, however, to be found when comparing the situation in West Pakistan with that in Poland, Germany and the Soviet Union. Of these countries, Poland would seem to have had, before the Second World War, about 40 per cent of the population dependent on local production, while 1.1 per cent of the total population lived in the ports Danzig and Gdynia. In Germany (excluding East Prussia) about 70 per cent of the population were engaged in local production, and 4 per cent of the entire population of the country were living in the six most important German seaports, viz., Hamburg, Bremen, Kiel, Stettin, Lubeck and Rostock. If these figures are reduced in proportion to the foreign trade of the respective countries, a country with a foreign trade of the size that West Pakistan is assumed to have in the future would, according to both the examples cited above, have about 2 per cent of its population living in its port. Since, however, the Soviet Union with its extremely small foreign trade had no less than 2.8 per cent of its total population living in the 7 largest seaports, viz. Leningrad, Odessa, Archangel, Mariupol, Vladivostok, Taganrog and Murmansk, there is every reason to keep a higher figure in view where Karachi is concerned. A proportion of 2 per cent of the total future population of West Pakistan would mean that a population of 0.8 million would be living in its seaport. Considering the great variations observed in this respect—which are particularly marked in the case of Soviet Union—this figure might well be increased by 50 per cent or more. One should therefore assume that the part of the population dependent on Karachi's function as a seaport and industrial centre may in future grow to a magnitude of some 1,300,000.

In most cases the capital of a country or of a province is what might be called a natural or geographical centre for the population of the surrounding area, i.e., the capital usually lies at the centre of the most densely populated area of a country. For this reason a number of capitals are situated in the interior. In some instances, however, the entire population, or an essential part of it, is concentrated near the coast, and in such cases it happens quite naturally that the capital, too, lies on the coast. On the other hand, no country other than Pakistan has a capital that is situated on the coast, in spite of the fact that the centre of its population and its most densely built-up area lies further inland. This circumstance renders it much more difficult to make an estimate of the city's future size, based on comparisons with other countries. A capital city normally, has, in addition to its administrative and cultural functions, to act as a centre of distribution and a centre for industries producing articles for the home market from indigenous raw materials. In federal states—where there are usually several, geographically separated, densely built-up settlements—efforts are often made to place the federal

capital in a neutral position *vis-à-vis* the different provincial capitals, which are each the centre of a province. This is the case, for instance, in the United States and the Commonwealth of Australia. In New Zealand a seaport on the route connecting the two islands has become the seat of the Government.

The purely administrative functions of a capital would require only a restricted population. The reason why most capitals have developed into big cities is probably due to the fact that, for their dual function as centres of distribution and centres for industries for densely built-up settlements, large numbers of workers are required. Purely administrative capitals without commercial importance, like Canberra and Bandoeng, contain no more than 0.2 per cent of the total population of their respective countries.

Pretoria, the capital of the Union of South Africa, which both acts as a provincial capital and serves an industrial area, contains 2.1 per cent of the total population of the Union, and Ottawa, the capital of Canada, which is the centre of an extensive timber trade, contains 1.6 per cent of the total population of the Dominion. Neither of these examples can, however, be compared to the situation in Karachi. Washington D. C. (including its suburbs) with 0.67 per cent of the total population of the United States (in 1940) should give the best idea of the requirements of an up-to-date country. It is true that, in the United States, technical and economic developments have reached a stage even beyond what may reasonably be expected in Pakistan within the next 50 years, but it seems nevertheless logical to assume that, in Pakistan, the personnel required for administrative and cultural activities will have the same relative numerical strength as in the United States today. Considering that the population of Pakistan will be less numerous, one would even have to allow for a slightly higher percentage. It is therefore assumed that the part of the population dependent on Karachi's capacity as federal capital and centre of cultural activities will in the near future correspond to 3/4 per cent of the total population of Pakistan or, in round figures, 700,000 inhabitants.

In order to fulfil its twofold function as a seaport and a capital, Karachi would thus have to have a total population of some 2 million, assuming the proportion of the working population in the city to be approximately identical with that of the occidental cities chosen for comparison. No recent statistical data in regard to this proportion are available for most of the countries whose population and economic life were directly affected by the Second World War. The data regarding Washington D. C. and Stockholm ought, however, to be more or less representative of the cities of the West, even if the statistics in both cases only refer to the city area proper, excluding the suburbs. A proportion of 46 per cent of the population of Washington were engaged in various occupations in 1940 and 55 per cent of the population of Stockholm in 1945. There are reasons for assuming that 50 per cent would represent an approximate average value. Thus, the above calculations regarding the population of Karachi imply that, in the year 2000, Karachi may be expected to have a working population—in both primary and secondary productive occupations—of about 1 million. Should this estimate prove correct, the total population may still vary considerably and exceed the estimated figure of 2 million. In 1930 the total population of Karachi was not twice but three times as large as the working population. If the same proportion were to be maintained, one would have to count upon a total population of no less than 3 million, but this proportion seems unlikely in the future. It is thus not improbable that, in this respect, too, Karachi may approach western standards, where about one-half of the population is working. On account of its large number of refugees, which has led to an appreciable deviation of the proportion in the opposite direction, Karachi will, however, have to reckon with a considerable time-lag before the working population reaches a higher proportion of the total population. To be on the safe side, it is therefore advisable, in planning for the future Karachi, to provide for a residential area capable of housing up to 3 million people, with a productive population of 1 million, even if a total population of, say, 2.5 million or less appears more probable for the period chosen. It must be kept in mind,

however, that Karachi may very well continue to grow for an unknown length of time after the 50 years dealt with in the Plan, and thus its population may eventually surpass any figure that can now be foreseen.

It should be observed that a simple adding up of the figures representing the parts of the population required for each of the city's functions (i.e. as a port and as a capital) may not give a true picture of actual conditions. It can easily be imagined that the very combination of several of the functions of a city may act as a localization factor for certain activities and thus result in a population numerically larger than the total attracted by each of the functions separately. On the other hand, it might also be argued that the present estimate pays no attention to the difficulties connected with the feeding of a population of several million in an area that does not produce any appreciable quantities of foodstuffs.

These and similar considerations are worthy of attention, and it cannot be denied that they introduce additional factors of uncertainty into the forecast for Karachi. An estimate made from a different angle would therefore be of outstanding value for the purpose of checking the statements made above.

In the section dealing with the future development of the population of Pakistan, it is assumed that the total "local production" population of West Pakistan will reach about 25 million by the year 2000. In other countries, with a "local production" population of roughly the same magnitude—between 13 and 50 million—in 1940, an average of slightly over 10 per cent of the population engaged in urban occupations was concentrated in the largest city and about 5 per cent in the next largest, but, in single cases, the deviations from this rule were considerable (for instance, Paris 16 %, Rome 6 %). In very densely populated areas there is no need for the urban population to spread over a large number of small towns. In such areas cities are generally larger than in sparsely populated areas. It is obviously difficult to draw any direct parallel to West Pakistan, but it does not appear unreasonable to assume that its biggest city would, in the future, house one-tenth of the population dependent on local production, or some 2.5 million inhabitants.

It is true that Lahore has always ranked first in size, and there is much to be said in favour of a further growth of the capital of the West Punjab, but, in view of the changes which have occurred since Pakistan attained independence, it seems probable that Karachi will be able to hold a future position as the largest city. This would to some extent corroborate the figure arrived at above, i.e. 2.5 million inhabitants.

There are further good reasons for investigating the rate at which Karachi would have to grow for its population to increase from 386,700 inhabitants in 1941 to about 2.5 million in 2000, and for finding out how this rate of the city's growth would compare with that of other cities. There are only nine cities in the world with a population of between 2 and 3.3 million (leaving aside Berlin, which had a higher population formerly). The stage of development that these cities have reached differs, but it may be said of most of them that they have attained a much further stage of development than the young capital of Pakistan. The table below shows the average rate of their growth from a size which corresponds to that of Karachi in 1941 to their present size, and the time that would be required if, at that rate, the population of the respective cities were to increase from 386,700 to 2,500,000, no account being taken of refugees. The figure on the page opposite gives details of the development of some of these cities.

City	Period chosen for comparison	Population in million at end of period	Average annual growth in per cent of population at beginning of each year	Number of years required for growth from 386,700 to 2.5 million
Los Angeles	.. 1910 — 1940	2.9	7.8	28
Detroit	.. 1900 — 1940	2.3	5.2	36
Osaka	.. 1890 — 1940	3.3	4.0	46
Buenos Aires	.. 1870 — 1945	2.6	3.5	54
Cairo	.. 1882 — 1947	2.1	2.8	67
Rio de Janeiro	.. 1870 — 1947	2.0	2.5	74
Calcutta	.. 1881 — 1941	2.6	2.2	84
Leningrad	.. 1820 — 1939	2.1	2.1	88
Philadelphia	.. 1860 — 1940	2.9	2.0	91
Mean	..	2.5	3.2	58

Between 1941 and 2000 Karachi's average growth would have to amount to about 3.2 per cent per annum, if a population of 2.5 million is to be reached. This figure corresponds to the average growth of the cities chosen for the sake of comparison, and only slightly exceeds the former average annual growth of Karachi, which was 3 per cent. The table makes it clear, however, that some cities have required a period of 33 years more or 30 years less than the average to register a similar growth, so that even this comparison should be used with great caution. In particular it should be kept in mind that the growth of cities requires enormous capital resources and that, in the days of the development of the large cities cited above, they could profit from funds available on a worldwide capital market. After two world wars the movement of capital from one country to another has, to a great extent, become hampered. If the lack of private capital cannot be compensated by an equal or a better supply of capital from other sources, this will seriously influence the growth of Karachi.

Finally, one is justified in asking how the great influx of refugees in 1947 and after will affect Karachi's ultimate size. It is quite clear that this stream of refugees has not affected the basic assumptions concerning national economy on which the foregoing argument is founded.

It also appears probable that Karachi's industrial life and the number of skilled labourers (in the western sense) in the town have not increased to anything like the increase of the total population. Perhaps certain branches of industry have expanded at a somewhat quicker rate than the average increase assumed above. Because the large number of refugees has reinforced Karachi's man-power and probably also its capital stock, this should make for favourable prospects for industry. The towns with which comparisons have been made above have nearly all also had short periods of a considerably quicker increase than their average. These have been interspersed with periods of slower growth and, in isolated cases, of actual decline. Karachi must be prepared for similar occurrences. Over so long a time as sixty years one can reckon that these periods of greater and lesser growth will counterbalance each other, and thus the recent large increase in population in no way contradicts the assumption that the average rate of growth for the whole period 1941—2000 will be 3.2 per cent per annum (or 1.8 per cent per annum for the period 1951—2000).

The expansion of a modern town is closely inter-related with the supply of electricity. Shortage of electricity puts a brake on industrial development. On the other hand, the availability of abundant and, if possible, cheap electric current is a great stimulus to industrial development which cannot thrive and flourish without it.

Provided that adequate means are taken to further the development of industry and trade, it is not unreasonable to assume that the population of Karachi will have increased to 2 or 3 million by the year 2000. This conclusion is based on certain assumptions regarding the development of the population of Pakistan, as a whole, and on the supposition that there will be an appreciable rise in the standard of living. It must be pointed out that, to a certain extent, the different arguments which have been advanced here are hypothetical, and that the fair agreement between the results of the various calculations may be coincidental.

Estimates regarding the growth of a population and of its economic life often turn out to be inaccurate when circumstances intervene which could not have been foreseen. This has proved true even in countries and cities where it has been thought possible to arrive at a fairly safe estimate for the immediate future—based on a continuous earlier development. The uncertainty inherent in any estimate made for Karachi is therefore evident. Nevertheless, bearing in mind many important plans that have been made for a high development of the economic life of Pakistan, and in view of the desirability to reserve ground space for what may reasonably be regarded as a maximum population in the near future, Karachi should, for the present, be designed to house an ultimate population of about 3 million people.

Anticipated Distribution of Occupations and Localization of Places of Employment in Karachi

The preparation of an up-to-date Master Plan presupposes special types of production areas for the various branches of industry to be set up in the city. It is therefore necessary to attempt to forecast the general structure of economic life in the Karachi of the future, so that areas may be laid out for different types of production in a way best suited to their purposes.

Such a rough estimate of the future economic structure and distribution of occupations might suitably be made by taking Karachi's two main functions, that of a port and that of a federal capital, as a point of departure. Since it has proved impossible to collect data referring to a city of parallel size fulfilling similar functions to those of Karachi, a partial analysis has had to be resorted to in this case also. Even so, the number of comparable statistics available is very limited owing to the inadequacy of employment statistics. It is even more difficult to obtain such statistics including the suburbs of the respective cities. One must therefore be content with data regarding localities within an administrative boundary, though this is somewhat less adequate from a comparative viewpoint. Thus, for the purpose of comparison, Washington, the capital of the United States, has been chosen to represent the administrative and cultural functions of Karachi, while the ports of Rotterdam and Gothenburg may represent its functions as a port and as an industrial centre.

The following table shows the distribution of labour in the above-mentioned cities in the years given below:

	Washington 1940	Rotterdam 1930	Gothenburg 1945
Production proper ..	18 %	46 %	50 %
Transport ..	8 %	24 %	15 %
Trade ..	30 %	23 %	23 %
Public administration and liberal arts	44 %	7 %	12 %
Total ..	100 %	100 %	100 %

This table does not include workers in such groups as "miscellaneous", "domestic service", "undefined", "unproductive occupations" and so on. The group "production proper" includes both the

census groups "production of raw materials" (agriculture, fishing and mining) and "preparation of raw materials" (industry, construction and crafts).

In order to arrive at an estimate of the probable distribution of occupations in the future Karachi, an average figure for this distribution in both the above ports has been computed. Since it is anticipated that Karachi will require twice as large a population for its function as a port as for its function as a capital, the average figure for a port has been doubled in the final calculation of the average figure for distribution of occupations in the cities mentioned in the table. If the result in per cent is rounded off to even figures, we get the following distribution:

	%	Number of persons
Production proper (agriculture and fishing 20,000, industry, etc. 380,000)	40	400,000
Transport	15	150,000
Trade	25	250,000
Public administration and liberal arts ..	20	200,000
Total	100	1,000,000

In both these tables the group "miscellaneous", implying mainly domestic service, is spread over the four specified groups of occupation. It may roughly be estimated that, as a rule, these groups cover 90 per cent, and the miscellaneous occupations 10 per cent, of the entire working population.

It is assumed that this distribution represents roughly the future occupational structure of Karachi. It is rather suggestive, as a matter of fact, of the distribution of activities in Stockholm, another city combining the functions of a port with those of a capital, and, in addition, occupying a very central position in a relatively densely populated district. In 1945, the figures for Stockholm for the above-mentioned categories of occupations were 41%, 11%, 28% and 20%, respectively.

Any estimate of the distribution of occupations must naturally be even more unreliable than an estimate of the future number of inhabitants, and therefore no attempt to calculate the relations of the different subheads to the main groups will be made.

With localization in mind, however, it will not be devoid of interest to study the approximate proportion between so-called primary activities and secondary activities. The primary activities of a city refer to those branches of its economic life which owe their existence to external causes—in the present case to the fact that West Pakistan needs a port and the federation, a capital. Secondary activities refer to those which develop because the inhabitants of a city need food, clothes, living quarters, transport, administration, etc. The terms "primary population" and "secondary population" refer to those groups of the population earning their living from primary and secondary occupations, respectively. Various studies of the relation between these two main groups show that the secondary population is somewhat greater in towns with commercial significance than in purely industrial towns. In large cities where the commercial life normally is well developed the secondary population generally represents about half the population. It is impossible to calculate these figures accurately, and not strictly necessary, since small variations in the ratio cannot exert any decisive influence on the localization problem.

Data regarding the ratio between the primary and the secondary population will be found helpful when making a first rough estimate of the production areas required in the different districts of the city, but for planning in detail other methods must be applied.

Thus, for the purpose of the present Plan, it has been considered necessary to regard the following five types of areas as suited each to one group of the occupations or industries specified below:

- (1) The central area for administrative and commercial purposes, i.e. an area with adequate facilities for outgoing and incoming passenger traffic, the commercial portion of which to be situated near the harbour and goods stations.
- (2) The port area, i.e. an area with access to quays and railway tracks.
- (3) The outer industrial areas, i.e. areas which offer good connections between different industries, have railway tracks, are situated close to the quarters of the working staff and provide good passenger traffic facilities. The ground space should be comparatively cheap and with possibilities for expansion.
- (4) Scattered work places and minor areas of industry in the residential districts, especially in their local centres, which are not meant for production on a large scale but nevertheless require a numerous staff to serve the population.
- (5) Certain districts on the outskirts of the city, i.e. districts which have large surface areas, natural resources or isolated sites.

The entire working population cannot, however, be expected to fit within these particular areas, since some of the inhabitants of a city have no defined space for their occupations, and even have to work beyond the boundaries of the city.

The different occupations which constitute the above-mentioned main groups of activities have been studied with a view to their localization requirements, and the following specification of the probable composition of the working population of the different areas has been established:

1. **The central administrative and commercial areas** must be expected to house most of the federal and municipal administrations, the centres of culture, the greater part of the wholesale and retail trade in specialized and high-class goods, the large banks and offices, and a large number of hotels, restaurants and amusement centres. In these areas there will also be located the central railway station, the head offices of the traffic and postal services, and a number of lighter industries and crafts requiring little space, such as printing works, certain mechanical industries, some of the textile and clothing industries and many other relatively unimportant specialized activities, which cannot be enumerated in detail.

It is estimated that, in Karachi, 32 per cent of the entire working population, or a total of 320,000 persons, will be engaged in these occupations.

2. **The port** must be expected to house the dockyard industries, the heavy metal industries, artificial fertilizer factories, etc., whose transport requirements are considerable. It will accommodate the stevedores, some of the railway workers, part of the staff employed in the wholesale trade and a number of customs officers. Fishermen are also included in this category. The total number of people who will be employed in the port area has been estimated at 10 per cent, or 100,000 persons.

3. **The outer industrial areas** should be suitable for housing most of the industries proper, especially those requiring considerable space, such as the metal, mechanical and building material industries, the foodstuffs industry, the textile industry and, to a certain degree, the heavier industries. It is estimated that the personnel in these areas will be 16 per cent, or 160,000 persons.

4. **The residential areas** will probably house, on the one hand, centres for retail trade, crafts, repair shops, equipment industries, schools and other public services, post offices and certain minor traffic facilities (such as messenger services, local railway stations, taxi-stands, etc.) and, on the other hand, the part of the population engaged in domestic work, primarily all domestic servants, but also certain craftsmen, etc. This group is estimated at 25 per cent, or 250,000 persons.

5. **The miscellaneous outer areas** will form a heterogeneous group embracing military cantonments, agricultural districts, salt works, quarries, airports, railway stations serving outer districts, marshalling yards, certain public works, etc. Consequently they will house personnel belonging to various categories of occupation, including the necessary secondary service personnel. The number of people who will be employed in these areas is estimated at 7 per cent, or 70,000 persons.

6. **In addition**, space should be provided in the above-mentioned areas for workers employed in such occupations as do not tend to confine them to any one particular area. Included in this category are seamen, a large proportion of personnel engaged in land transport whose work takes them to different places, construction workers, police on patrol, ambulatory tradesmen, commercial agents, and people engaged in other miscellaneous occupations, making an estimated total of 10 per cent, or 100,000 persons.

CHAPTER IV

ADMINISTRATION AND CULTURAL INSTITUTIONS

The "Capital" has a twofold function—one of an ideological nature, the other practical. It will manifest to the people of Pakistan and to the world the ideal for which the state stands. The vision and faith of the nation will be materialized by artistic and architectural means. The impression given by the Capital will, among other factors, depend on the grouping and concentration of the most important buildings.

The administrative buildings should not be spread over large areas. For practical reasons a certain degree of concentration in modern multi-storey buildings is also recommended, facilitating personal contacts.

The administrative centre of the Capital should be connected to other parts of the city, and especially to the Central Commercial Area, since good contact between the national administration and commercial life is becoming more and more essential.

The University and other cultural institutions should also be closely connected to the Capital and to the city centre, thus linking up culture and science with administration and production.

Ground for residential areas for Government officials, diplomats and other prominent people should be reserved in the Capital area.

Central Administration

The Capital area, that part of Karachi which will stand out as the seat of the Government and embody all its functions, will have an ideological as well as a practical nature. The Capital will manifest to the people of the country and to the world the ideal which lies behind the creation of the State of Pakistan.

The vision and faith, from which the people of Pakistan draw their strength, will flourish here, made visible and comprehensible through that artistic and architectural conception which is Karachi, the heart of a new country.

Here the leaders of the country will be given the opportunity for that mass-contact with the people without which the sense of community cannot survive. Great open squares and boulevards are planned, where the people may gather for public assemblies, Idd prayers and parades. Small quiet parks and open-air cafés will be the setting for everyday private discussions and exchange of ideas. As a background for the whole picture the mosques and public buildings will, by their disposition and architectural character, be a visual manifestation of the fundamental common ideal.

No architectural achievement can be compared in significance to the creation of this centre of the country. And just as Pakistan itself is a new creation arising on old ground, so should the architectural style of its capital be new, although springing from a living tradition. There should be no question of a mere importation of the eclecticism which characterizes certain western architecture, nor of creating a pastiche in the Muslim style, which would be nothing but a mechanical adaption of an old mode.

The Capital has also its practical mission. It will house all institutions necessary for central state co-ordination within a modern society. Large areas must be kept in reserve for future growth of the

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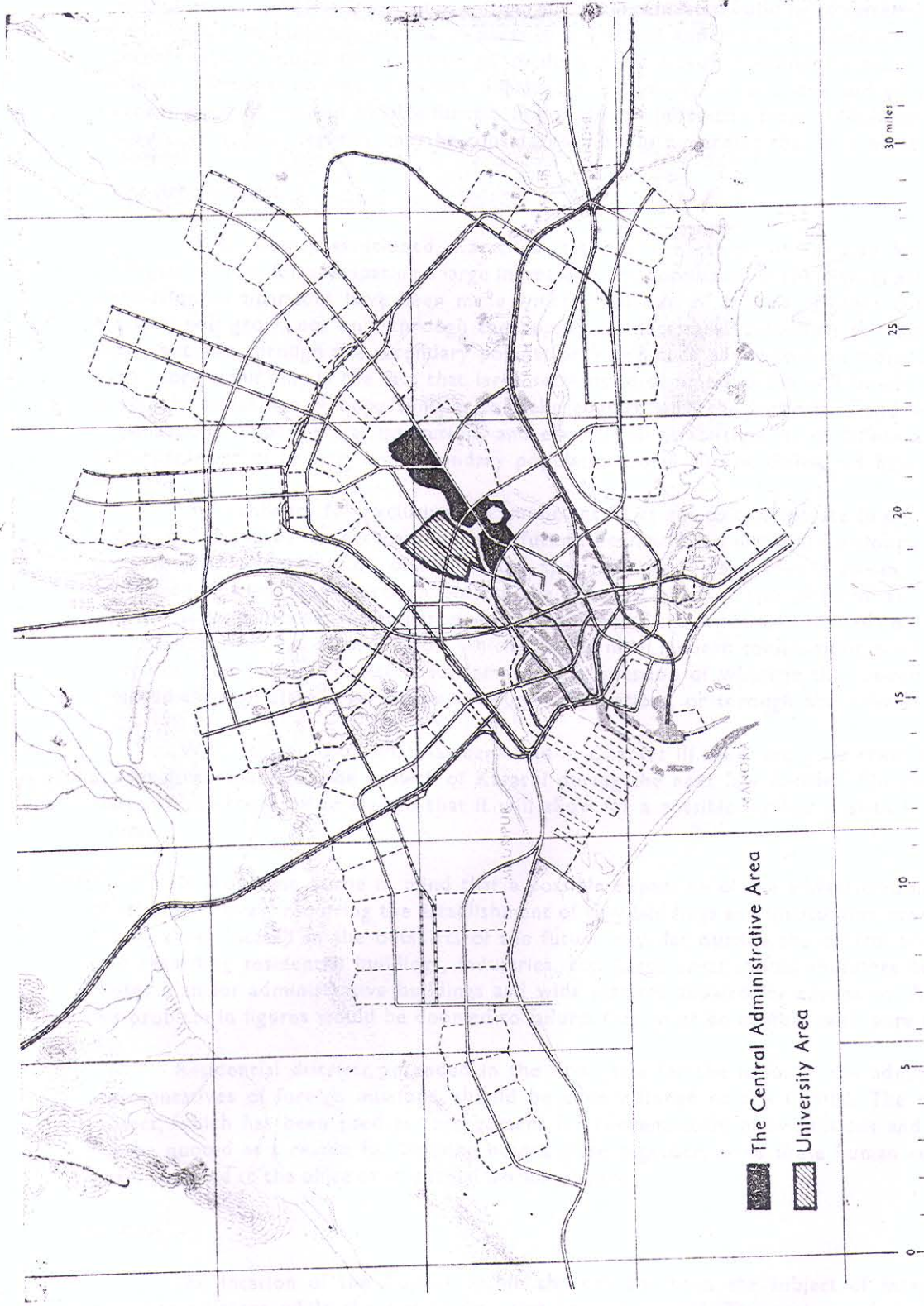
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Residential districts, intended in the first place for the heads of the administration and for representatives of foreign missions, should be closely linked to the Capital. The need for personal contact, which has been used as an argument for concentration of institutions and work-places; can be met in these districts where human contacts are by no

Capital and such a layout planned as will permit of concentrated building in certain parts. The dispersal of administrative buildings over large areas is impractical and should be avoided. A certain degree of concentration through the erection of modern multi-storey buildings is recommended where it facilitates personal contacts between different governmental institutions and officers, an important factor in the efficient and flexible functioning of the administrative system. New Delhi, and other such products of ancient regimes, may be considered more as a warning than as a model in this respect.

Space Requirements

As previously mentioned, Karachi's status as the capital of Pakistan has been one of the strongest reasons for anticipating a large increase in the population of the city. In estimating the future population, comparisons have been made with populations of capitals of other countries. Karachi as a capital will grow, not only through the population necessary to conduct the administration of the State, but also through the secondary population which such administrative work brings in its wake. Even more significant is the fact that large sections of commercial life will be concentrated here, so as to take advantage of opportunities to make contact with the authorities and with administrative organizations. Experimental institutions and educational establishments of different kinds, with their accompaniment of primary and secondary populations, will also be developed here.

This tendency for exclusive and important functions to concentrate in the capital is manifest today, and it will be no less marked in the future. Technical and material development cannot advance without progressive division of labour and specialization. This tendency to specialize entails a co-ordination and local co-operation both of the different forms of specialization and of the specialists. In this respect it is necessary to perceive what lies behind the tendencies towards centralized direction and concentration, i.e. co-ordination, which is found in all modern communities, irrespective of political structure. The political aspect is fundamentally a question of whether this co-ordination should be achieved through state organization, through corporations, or through the individual.

With reference to what has been said in Chapter III there are good reasons for adopting the figures given there for the growth of Karachi during the next few decades. On the other hand, the Master Plan should be so framed that it will allow for a possible further growth in the more distant future.

It should be borne in mind that a possible expansion of the administration of the State and of related services, requiring the establishment of new buildings and institutions, cannot be satisfied by having these located in the outskirts of the future city, far outside the central area, as may be the case regarding residential buildings, industries, etc. Large areas should therefore be reserved in the Master Plan for administrative buildings and wide margins allowed for expansion. Attempts to define this problem in figures would be doomed to failure. One must be content with pure conjecture.

Residential districts, intended in the first place for the heads of the administration and for representatives of foreign missions, should be closely linked to the Capital. The need for personal contact, which has been used as an argument for concentration of institutions and work-places, can also be quoted as a reason for building houses close together, since these human contacts are by no means confined to the office or to normal working hours.

Location

The location of the Capital within the city has been the subject of many discussions and divergent opinions while the Master Plan was being prepared. The authors of the Plan have, at an early stage, emphasized the desirability of promoting as close a contact as possible between the state administration and the economic and cultural functions. Specifically this means that the Capital and

its administrative buildings should be located near the old town, with its business life and its cultural institutions, as well as near the new areas set aside in the Plan for this purpose. The desire to isolate the Capital in a new and separate town, or section of the town, has appeared to the authors to be an echo of ideas from a past era during which the functions of the state were confined merely to the responsibility for a certain degree of order and a certain dispensation of justice. In such a community, the state system could be segregated and could, in magnificent surroundings, manifest its supremacy in splendid isolation. In a modern community the state has increasing and even more important tasks in all spheres of communal life, not least in the economic sphere. It is therefore of paramount importance that this system should have the best and most intimate contact with other functions of the community, and it cannot be disputed that their relative locations have an important practical bearing on the matter.

The location of the Capital, which was decided by the Authorities before the work on the Master Plan began, does not entirely correspond with the opinion held by the authors of the Plan. Since its location was assigned as a definite condition for work on the Plan, it has been incorporated in the Master Plan by linking the core of the old town and the Capital together as intimately as possible through the arrangement of the street and communication system.

Lay-out

Bandar Road today runs like a mighty three miles long artery through the town, from the port to the Quaid-i-Azam Monument. The Master Plan carries the road further, widens it, and gives it a symbolic significance. From the Quaid-i-Azam Monument—the symbol of the people's faith and destiny—situated at the highest point of the road, Bandar Road, or Bandar Road Extension, continues into the new Capital area, up to the Parliament building, and thus finally unites the old town, with its teeming business life, and the new Capital, manifesting the nation's will and destiny.

On reaching the Parliament building in the Capital, Bandar Road widens out to form a large open space, framed by public buildings and dominated on one side by a mosque and on the other by the Parliament building itself. The place is conceived as a hexagon, each side 1,400 ft. long, where up to a million people can gather. It is paved with marble, has cool, shady trees along its sides, playing fountains, and a great lake in the form of the crescent and star, whose gleaming mirror of water catches the eye of the airline-passenger from an altitude of many thousand feet, and holds it long after the city's contours begin to fade in the haze. It is the place conceived for Idd prayers, for large meetings, public assemblies, popular festivals—the place for public ceremonies. It is the Forum of the nation.

University

A university, in a modern sense, is as much an organization for research as for education. Modern universities are places where new methods are developed in almost all branches of modern life, viz. science, technology, medicine, art, sociology, etc.

Higher education is very often given in special institutions, such as polytechnic or medical schools, where students are trained for different professions and where many sciences and arts normally studied at a university are taught. Intercommunication between various sections and faculties with the same or related subjects in their programme is desirable for the sake of efficiency. Further, the possibility of common lectures for students in the different branches of the university will stimulate the wider and more general cultural and social interests which should be required of the specialist, preparatory to taking up his professional work. Therefore, the various sections and faculties of higher education should be kept together and dealt with as a unit, the University.

Research cannot be carried out properly without close contact between the University and the object of the investigation. Since many of these necessary contacts can be obtained in the

Administrative and Commercial Area and in other parts of the city, the work of the University is similar to other kinds of work which call for a central location communicating with all parts of the city and all levels of society. Research in economics and medicine may be cited as examples of work of this kind. Medical research requires special consideration, since it is dependent on wide practical experience and must be mainly attached to a large hospital. Such a hospital, on the other hand, must be so located as to ensure good communication with all parts of the city.

Many facilities available in a university, such as libraries, laboratories, testing equipment and museums or collections, are of great value and in many cases essential for work not only in the university but also external to it. Such facilities should therefore be easily available to all. Rapid developments in many branches of science have made it desirable to extend the period of theoretical learning over almost the whole productive life of professional men. Education in a modern university is therefore not only a matter of imparting knowledge to students during the years they spend there, but also of supplementing the previous studies of graduates. To meet this requirement, there is now a tendency for universities to hold short courses which are specially adapted to fulfil the needs of university graduates working in a professional capacity. The material resources and highly qualified staff of a university might sometimes also be utilized for education at a lower level and the arrangement of evening courses for this purpose would be a normal procedure.

If the University is located apart from the city in order to isolate deliberately the University and the life in it from outside influences, higher education might tend to produce a group of intellectuals separated from other groups of the people, which would be detrimental to society as a whole.

The University should not be considered as an entirely residential establishment. To a great extent students will live with their families or other relatives in different parts of Karachi. The logical conclusion of these considerations and of what has been said in the foregoing paragraphs is that the University should be located so as to have the best communications with all parts of the city.

It is impossible to calculate the probable number of students at the University and polytechnic schools in the future. This number will depend on the development of the population and culture of the country. The number of students in relation to population in some other countries has been investigated and is shown in the following table:

U. S. A.	4	students per 1,000 inhabitants			
Norway	3	"	"	"	"
Denmark	2.5	"	"	"	"
Sweden	2	"	"	"	"
England	1	student	"	"	"

The American figure includes students in certain pre-academic schools.

It may be assumed that the number of students in the University of Karachi will not greatly exceed 20,000. This figure corresponds to the number of student in the biggest residential universities in the U. S. A. With an average area of 3 acres per 100 students, this will give a required total area of about 600 acres.

An area of at least 200 acres should be reserved for the central hospital, which should adjoin the university area.

Furthermore, sites will be needed as reserves for institutions for scientific research and experiments, which will be more or less closely linked with the University, though nothing definite can

be said at present concerning their nature and scope. The extraordinarily rapid development in science during the last 100 years, and the resulting large space requirements, indicates, however, that these reserves should be liberal. It is also desirable that sites should be reserved within the university area for houses for the university personnel and for a certain proportion of the students.

An area of about 1,500 acres has been set aside in the Plan.

Other Public, Cultural Institutions and Activities

In addition to the University, such public institutions as the central library and museums will belong to Karachi, which will constitute the centre of the cultural life of the future Pakistan. Plans have already been drawn up for the construction of a National Library and a National Museum.

These institutions, being intended primarily for students and research workers, will also give a wider public an opportunity of obtaining, in a comprehensible form, a proper conception of the cultural situation and its connection with natural conditions and history. They should therefore be easily accessible to the inhabitants of the city and to visitors. Thanks to the location of the university area in the Plan they could be placed without difficulty in the same district, thus making possible a more intimate co-operation between these institutions and the special libraries and collections housed in a university. It may also be said, however, that the National Library and the National Museum form part of the manifestation of the communal spirit of the people which has its nucleus in the administrative area. It is suggested that the institutions in question be located at the "Entrance of the Capital", since it is important that as much emphasis as possible is laid, at least at an early stage, on this part of the town.

Karachi, as the cultural capital, will also be the centre of far-reaching private activities of a cultural nature. This refers, for instance, to art and literature, as well as to book publishing, magazine and newspaper editing, and to societies of different kinds. In modern cultural centres, such activities occupy tens of thousands of people. Considering the degree to which the Capital and the University may be extended, it appears probable that activities of this kind will be carried out in their vicinity, within the Central Commercial Area.

Defence

It may be assumed that the Central Defence Organization will be established in the Capital, so that the best possible contacts can be maintained with the Government and with other branches of administration. On the other hand, the military administration is not likely to require a larger area than the civil administration with tasks of similar magnitude. The Master Plan should not of course indicate in any detail the location of the more acreage-demanding defence organizations which the capital of the country will need—only parts of the Karachi Cantonment have been shown on the map as Military Areas. It should, however, be emphasized that, when the city expands, the central parts of the city area should not be used for widespread defence establishments.

CHAPTER V

TRADE

Wholesale trade is, and will remain, of primary importance in Karachi. Particular attention should be given to this branch of the commercial life and necessary reserves made for future expansion.

Ground reservations are suggested for:—

- (i) Offices and small warehouses in the Central Commercial Area.
- (ii) Storage depots and warehouses, partly on reclaimed land near the Port and freight station.
- (iii) Market places and certain offices in the District Centres and near the Fishing Harbour.

The premises of business firms should be located near each other to facilitate the best possible personal contact. This means concentrating offices to fairly densely built-up areas in the city centre.

Retail trade should be divided into two types: shops selling speciality or quality goods, and shops selling food or other commodities of daily consumption. The first type needs a central location easily accessible from all parts of the city. The second type has to be located within convenient walking distance from the residential buildings. Both types are provided for in the Plan.

A strong development of motor traffic may cause extreme demands for parking space in a city's central areas, which may be impossible to satisfy. This has resulted in a tendency, clearly apparent in the U. S. A., to establish new sub-centres outside the densely built-up town and easily accessible by car. District centres are provided in the Master Plan in anticipation of such a tendency.

It is estimated that the total working population of the Central Commercial Area and the adjoining area for Mixed Development will be 300,000 in about fifty years' time. Approximately 3.5 sq. miles will be set aside for the Central Commercial Area, which will be large enough to house not only trading concerns but also residential buildings. In the Mixed Development areas more space will be provided in a central location for residential buildings.

Wholesale Trade

As mentioned before in Chapter III, the wholesale trade is of primary importance in Karachi and has a strong influence on the development of the city. A great deal of attention should be given to this branch of trade, since it can be expected to employ many tens of thousands of workers in the future and will require a large amount of space as well as good communications.

The most important wholesale premises are warehouses and supply depots. As a rule, the wholesalers prefer to locate their warehouses near a reloading centre having as good a contact with the business life of the city as possible. Wholesalers who deal with relatively small but costly goods prefer to combine warehouse and office in one building in the Central Commercial Area, while business firms dealing in bulk and quantity goods should be satisfied to have their storehouses located near the Harbour or in the freight station district, but with a separate office, centrally situated.

For wholesalers who sell only to retailers within the city, and particularly for those concerned with the foodstuffs trade, there is some need for other locations. Advantages would be derived from a certain spreading out in different districts, especially by those merchants dealing in perishable goods. As a very large section of the population will live in the inner city, a considerable part of the perishable goods trade will be located in this district. In both the inner city and the outer districts, it is conceivable that a daily market will be arranged where wholesalers and retailers can meet. The central market can suitably be located near the wholesale warehouses, while each individual district may have its own separate market. A special site for a fish market will be needed near the Fishing Harbour.

It is difficult to give any specific data on the space required for warehouses for the wholesale trade in Karachi. Industrial and commercial statistics in different countries are normally concerned only with the number of employees in this section of trade. This gives very little guidance for determining the space requirements, since these will vary with different kinds of wholesale enterprises. In Sweden, for example, about 400 sq. ft. of floor space per employee is the figure used when estimating the storage space for textiles, while the corresponding ground space for storing iron and metals is 4,000 sq. ft.

Ground reservations are proposed to be made for:—

- (i) Offices and small warehouses in the Central Commercial Area.
- (ii) Storage depots on reclaimed land at Chinna Creek, easily accessible to railway and barge transport, and some warehouses, particularly those concerned with international wholesale trade, preferably located in the harbour area.
- (iii) Market places and certain offices in the District Centres and near the Fishing Harbour.

Organization

In every big city there are a large number of activities which are different from each other, but which require a common central location. To this group belong all kinds of organizational and administrative enterprises connected with the public, such as banks, insurance companies, shipping offices and brokers, as well as the head offices of various professional organizations, trade unions, etc. In Karachi there is a Stock Exchange where buyers and sellers may meet daily for transactions in securities and staple goods. Personnel of the leading organizations, apart from conducting transactions on the Stock Exchange, spend much of their time on matters concerning agreements and contracts with other firms. Conferences and other personal contacts are essential; agreements must be confirmed in writing by the negotiating parties, resulting in a continual circulation of personnel and documents among the various offices. It is therefore of the greatest importance that offices should be near each other in order that the work of the organization may be carried out quickly and effectively. The commercial district should therefore be concentrated as much as possible. Ready contact with the administrative authorities is already a significant factor in business transactions and will probably be of still greater importance in the future. Proximity to the Capital area is therefore essential.

In the district where the large trading firms are located, offices should also be found for commercial agents, brokers, solicitors and other professional men, many of whom assist in business agreements and organizational work.

For the convenience of those working there, the centre should be well equipped with restaurants, cafés, office supply shops, small food shops, post and telegraph offices, branch offices of banks, etc. This does not prevent the utilization of the ground floors of most buildings for shops of all kinds, giving the district a less one-sided character and using the street frontage to the best advantage.

Offices of various types, certain industries and warehouses, shops, etc. have a floor space of 100 to 150 sq. ft. per employee in the centres of the big cities in western countries. This applies for example to the Empire State Building and to the Rockefeller Center in New York City, as well as to centrally-located business concerns and industries in Stockholm. These data would probably apply also to Karachi. It is true that the hot climate would appear to warrant more floor space per person in Karachi than in New York or Stockholm, but extensive use of air-conditioning will tend to counterbalance the desire for spacious premises. The number of persons per acre can, without inconvenience, be much higher in a city section with only a daytime population than in a residential district. The Rockefeller Centre, with its approximately 17 acres of ground area, accommodates 1,500 to 2,000 workers per acre. Such peak figures do not of course apply over larger areas. Thus the City of London has somewhat more than 600 workers per acre, while in the centre of Stockholm there are around 400 persons per acre, including a small proportion of residents. Manhattan Island in New York, which is predominantly a residential area, has around 300 persons per acre, including residents.

The central areas of London, New York and Stockholm are all very densely built up even if the variation in density of population is considerable. In planning the centre of the future Karachi one should therefore not exclude the possibility of a less dense development. For the purpose of the Master Plan the density of population for this area of Karachi is estimated at 200 persons per acre.

The main part of the various branches of business within this group will probably be established in the present central district at Bandar Road and McLeod Road, where land is reserved for this purpose.

Retail Trade

The opportunities offered for an extensively ramified retail trade may also be considered as one of the causes for the growth of big cities. Even where, as in the Plan for Karachi, a large part of the population is assumed to reside and work in the outer districts of the city, many people will go to the town centre for certain purchases.

Enterprises which seek a central location are, primarily, shops selling speciality and quality goods for which there is so little demand that a few specialized shops are sufficient for the whole city's need, or dealing in certain commodities, e.g. fashion goods, which customers like to examine and compare with those in other shops before making purchases. Big department stores also naturally look for central locations easily accessible from all parts of the city. The best sites in the centre are on streets with a large number of pedestrians. These streets may be either the main thoroughfares carrying heavy traffic (provided that they have such broad pavements that pedestrians are not inconvenienced by motor traffic) or special footways leading to junctions in the system of public transport.

In working out plans for the retail trade, the bigger shops should be provided, where possible, with entrances for receiving goods from small streets at the rear of the premises. Lorries unloading goods in front of shop entrances not only interfere with shoppers but are also a common cause of traffic jams on the main thoroughfares. It is also of importance that a sufficient number of parking places are provided near shops, and that these spaces are not used for all-day parking by those working in the district. Large scale enterprises, such as department stores, should provide their own parking facilities.

As previously stated, a certain amount of wholesale trading and office activities should be anticipated in the proposed District Centres. At an early stage of development retail trade may be established there only to a small extent. It is a relatively new tendency in the big cities of the West for the large business enterprises to open branch departments in the outer districts of the city in order to make their merchandises easily accessible to the customers. This trend may also influence development in Karachi, and sites for local shops of this kind will be found in the District Centres. The main buildings of these firms will, however, always be located in the centre. District Centres cannot be

situated within convenient walking or cycling distances for more than a very limited section of the population. With a well-developed system of public transport it is probable that those who, in any case, have to use buses or suburban trains in connection with their shopping will find it more advantageous to travel as far as the city centre with its wider variety of goods. Should, on the other hand, the system of public transport be little developed and a large number of private cars be used instead, the District Centres may also be of importance for shopping. This is the present trend in some large American cities.

Foodstuffs and other more or less standardized commodities of daily consumption, which form the main part of the retail trade, should be sold within the Neighbourhood Units. Certain foodstuffs and articles in general use could be sold to advantage in smaller shopping centres in the residential areas within short distances of the houses, while the great majority of shops requiring a somewhat greater public support should be concentrated in the Neighbourhood Centres. These shops should be large enough to offer a complete assortment of merchandise for the daily needs of the residents. Shops are generally only at street level, while the upper storeys of the buildings are used for other purposes, such as offices or flats.

The growth and localization of "shopping centres" will depend mainly on where the inner communications are best developed, where it will be easy to build, and where certain leading concerns, e.g. department stores, have already established themselves, attracting public and other retail businesses, etc. The most likely location for the "shopping centre", and the most desirable for the city, is one that is easily accessible from Bandar Road. Among other developments, the present retail trading district at Saddar Bazaar can be expected to extend towards Bandar Road. It is also very likely that the district around Boulton Market and the bazaars in the old town will be further developed.

Hotels, Restaurants, Places of Amusement, etc.

Commercial activities will create a great need for hotels and restaurants in Karachi, the great majority of which are likely to be located in the city centre or its immediate vicinity.

Many of the hotels and clubs in Karachi are situated in the district between the Cantonment and Kutchery Road. South of the railway station at Chinna Creek a similar development has taken place, and the district has been set aside in the Plan mainly for this purpose, not only because of the fine situation, but because it is well located in relation to inter-urban communications and the business district at Lower Bandar Road. Moreover, there will be a large number of hotels established in the centre itself, and in the Capital, as well as near the beaches at Clifton and Buleji.

The larger theatres, cinemas and more prominent places of amusement should be located mainly in the city centre, and their requirements as to location are similar to those of retail establishments.

Exhibition halls, art galleries, etc. will also require central sites. Industrial fairs and other big exhibitions, which cannot reasonably be accommodated in the centre, have been allotted an area in the southern part of the Trading Estate where communications with the Commercial District are good.

Lay-out of the Central Commercial Area and Areas for Mixed Development

Commercial and related activities mentioned above, together with the centrally-situated industries, can be expected to require an area of, say, one square mile in the future city of Karachi.

In the Plan an area of about 3.5 sq. miles, adjoining the Administrative Area, has been set aside for the Central Commercial Area. The reason for setting aside such a large area for commercial

purposes is to provide space for a great future extension and thus to realize one of the main ideas of the Master Plan, viz. to concentrate the activities of the future Greater Karachi in one common centre. Furthermore, there will always be need for housing accommodation in the centre. It is obvious that the large reservation of land along the main axis—Bandar Road—will make a certain differentiation of activities within the central district possible.

Theoretically, all enterprises attracted to the centre tend to establish themselves in or near the same very limited district. For various reasons differentiation takes place in many big cities, so that one type of firm seeks a location in one part of the centre, while another type establishes itself in another section. A somewhat extreme example of this can be taken from New York City where big business has offices on the southern extremity of Manhattan—Wall Street—whereas retail trade is centred about 4 miles to the north. This distance is considerably greater than the length of Bandar Road from the Port Trust Office to the Quaid-i-Azam Monument.

Assuming that good communications can be developed between the different parts of the centre, a natural division of districts along the city's main axis should not be a disadvantage, but rather to the contrary, since the different branches of commercial life will then have the possibility of developing more independently of each other. It is proposed that the suburban railways, as well as many express roads, should run to the central district, and that street widening be undertaken to make possible quick and frequent bus connections in the centre.

Certain sections of the commercial life directed towards the centre are already established in district outside the proposed Central Commercial Area. The location of hotels and clubs between the Cantonment and Kutchery Road has already been mentioned. There are also at present many small industries and other business activities around Lawrence Road. In the Plan these districts have been marked for Mixed Development. It is intended, in the first stage, that those sections of commercial life already established there should be further developed, but that the districts should be used mainly for residential buildings.

The ground in the centre that is not claimed for business activities will be used for other purposes, primarily housing. During the early stages, housing construction will predominate. As the city expands, blocks of flats and other residences will be taken over for offices and shops, for which higher rents can be charged. Bearing this in mind, it is important that the responsible authorities should, by means of detailed planning, provision of traffic aids and parking places, etc., stimulate the establishment of business activities, offices, shops, hotels, restaurants and theatres around the main axis of the Plan, i.e. from Lower Bandar Road to the "focus of the Capital", while the existing purely residential districts should be located more to the side of the main axis. Only in this way can the people achieve that active city life which should be characteristic of Karachi's future centre.

If the number of people working in the central area and the areas reserved for Mixed Development amounts to roughly 300,000 and the residential population to 400,000, as has been assumed, the number of workers and residents in central Karachi will be about 200 per acre.

CHAPTER VI

INDUSTRY

Industries need contact with supplies, labour and customers. The best location for an industry depends on which one of these contacts is the most important.

Contact with supply means location close to the railway and, in some cases, near the Port. In the Master Plan the main industrial areas are located so as to comply with these requirements.

Contact with labour means that industrial areas should be easily accessible from residential areas. In the Plan industrial areas are attached to most of the neighbourhood units, enabling many workers to live within convenient walking distance from their place of employment. Further more, the system of communications is planned so as to facilitate cheap and rapid transport between all industrial and residential areas.

Contact with customers means location in or near the City Centre, District Centres or Neighbourhood Centres. This applies to "service" industries, printing industries, etc.

Factories and dwellings should generally not be mixed, and all large industrial enterprises must be located in particular industrial areas. Above all, annoyance from industries causing unpleasant odours should be avoided by locating the factories in areas on the leeward side of the residential areas.

In order to avoid a corrosive effect from salinity in the air, industries which do not require to be located near the sea should be built away from the seashore.

The development of industries should be encouraged by the organization of Trading Estates.

It is estimated that of the 380,000 workers assumed to be engaged in industries in the future 110,000 will work in the centre of the town and in the Port and 160,000 in the outer industrial areas. These outer areas will cover about 5,400 acres.

Much of Karachi's future lies in its special qualifications for industrial development. Being the Port for practically the whole of West Pakistan, Karachi offers an advantageous location for dockyards, oil refineries, steel and metal works, industries connected with building materials, factories for canning and packing, etc. The growth of the city's importance as the centre of the country for administration, private organizations and commerce will also attract establishment of enterprises dependent on these activities. The needs of the large future population of Karachi will support extensive secondary industries, which will gradually introduce their products to a large market and thus eventually become primary industries.

It is of importance that industry and commerce should be well catered for and offered the best possible facilities, such as adequate space, good transport and good public services. On the other hand, the interests of other districts of the community should be safeguarded, e.g. the residential districts should not be subjected to smoke, odours, noise and other annoyances.

Contact with Supplies, Labour and Customers

Industry and commerce should be in good contact with supplies, workers and customers, so that the transport requirements for both personnel and goods will be as low as possible, the labour supply adequate and the best possible service offered to the buyers.

Most of the primary raw materials are not available in Karachi or its immediate vicinity, the industries based on quarrying constituting only a small fraction. It can be assumed therefore, that raw materials and semi-finished goods will be brought in mainly through the Port, the railways and, to a lesser extent, the highways. To facilitate service to the consumers, the best location of the industrial districts would be near the railways or, if this should not always be feasible, near the express highways. Undertakings particularly dependent upon ocean transport of raw materials and finished goods should be accommodated in the harbour area. If, however, the location of an industrial district is determined by other factors, then every effort should be made to provide it with good railway and road connections.

One of the important advantages of the large city is that it offers both a large labour supply and a variety of employments, providing that, in principle, all places of employment are easily accessible from all residential areas. Thus the planning of the city must be based on the demand for a general contact between the residential areas and the working areas. On the other hand, it is important to provide accommodation for those who desire to live close to their place of employment. This will mean cheaper transportation and less strain on the system of transport. The Plan must therefore ensure that working areas should be close enough to the residential areas to satisfy this demand. Naturally, even if there are facilities for residence in the immediate vicinity of the place of employment, by no means all persons will take advantage of this. Those who find themselves pleasantly situated in a certain part of the town may prefer the long journeys to the disadvantages of moving their homes. In addition, if several members of the family are employed in different districts, it is impossible for them all to live near their particular places of employment. Nevertheless, a considerable reduction in the traffic flow can undoubtedly be achieved by decentralizing the places of employment, particularly in a "new" city where new industries and residential buildings are being built simultaneously.

An interesting example of the conditions mentioned may be taken from a very large industrial concern in Stockholm which formerly had a central location in the city but which in 1939 transferred its entire premises to a more outlying district, the employees being offered houses or flats near the place of employment. The percentage of the labourers and supervisory employees who moved to the part of the city near the new place of employment grew as follows :—

1939	..	..	..	..	13 % (before moving)
1942	..	..	..	..	35 %
1945	..	..	..	..	50 %
1948	..	..	..	..	61 %
1950	..	..	..	..	61 %

More intimate contact between residential and industrial districts can make the urban environment more varied and interesting. This is of special importance for children and young persons who have not yet entered employment. For them it means seeing the working places of the adults, learning to know life and making a contact with reality which is of the greatest value in rearing them to be active members of the community.

For many industries direct contact with the market is of decisive importance for their localization. This would apply, for example, to the printing industries and to different kinds of service industries and trades, such as garages, laundries, drycleaners, shoe repairers, etc., and would mean that such industries will have to be established in the City Centre or Neighbourhood Centres.

Hygienic Factors

Industrial activities may cause many kinds of annoyances and disturbances. They might be aesthetically objectionable, like many of the older, badly-planned factories without greenery and without the benefit of good architectural design. They might cause noise, like a stone crushing plant,

smoke, like most factories using coal for fuel, or odours, like a bone meal plant. The aesthetic defects appear to diminish where there is modern factory planning. Good organization of industrial districts with the use of trees and shrubbery for their softening effect, good architectural design of the buildings, and the use of electric power, often make industrial areas more a stimulus than a disturbance in the urban environment.

Complaints about noise in the metropolitan areas most often refer to the noise of traffic, wireless receivers, and so forth, and less often to factories. Nevertheless, some industrial equipment, such as stone crushers and riveters, might be very disturbing. Effective insulation of these sources of noise can be extremely costly, and it is usually economic to choose the sites for such equipment with care. Surrounding the industrial areas with isolating zones reduces the risk of disturbing other parts of the city; the effect is even better if the zones are planted with trees and shrubbery.

In most large industrial cities, smoke and soot are a nuisance which affect the greater part of the population. As a result of firing which coal in combustion equipment which is not always efficient, the factory chimneys spew out smoke and soot day after day over the parts of the city which have the misfortune to be situated nearby. The facades of buildings become black, and if a window is opened, soot will cover the floor and furniture. The use of better fuel and improved combustion can considerably reduce the amount of soot. Beyond this, however, only a rational localization of industrial and other types of construction in relation to each other can help. At present, factories and dwellings are often mixed together, lying wall to wall and without respect to the direction of the wind. It is also advisable with regard to the problem of soot and smoke to surround industrial areas with vacant isolating zones. The area towards which the prevailing wind blows from the soot-producing factories should be left vacant.

Bone meal plants have an especially bad reputation for their smell. There are some ways of reducing the odour, for instance by filtering the exhaust air and adding ozone to it, or by balancing the capacity of the plant against its intake of raw material, so that the rotting of the material in storage is reduced, but completely effective measures are expensive. It is, therefore, important to consider carefully the location of such industries. Isolating zones and the avoidance of building construction in the area to which the prevailing winds blow from such plants are also advisable in these cases.

Defence Considerations

Where it is not possible to construct industrial establishments in rock caverns or the like, the most effective defence technique is probably to scatter them so that they do not offer a concentrated target for bombing. The desirability of decentralization is thus apparent. The effect of bombing can be further modified by introducing fire lanes both within the industrial districts and between these and the residential areas. These lanes, which prevent the spread of fires, are naturally useful in peacetime also.

Salinity of the Air

The problem of corrosion is very serious for industrial establishments having large exposed metallic surfaces. The percentage of chlorides and sulphates in the air is of decisive importance. Both these salts occur in varying concentrations in the atmosphere, the percentage depending on the distance from water of high salinity. The sulphate concentration is also greatly affected by the proximity of industries using coal as fuel.

The data given below, obtained from the Committee on Corrosion of the Swedish Academy of Engineering Sciences, illustrate the problem:

Location	Woolwich (approx. 3 miles E. of Greenwich outside London)	Berlin-Dahlem (suburb of Berlin)	Ijmuiden (on the North Sea coast of Holland)
Remarks	Quite near salt water. Near industrial establishments	Far from salt water. Quite near industrial establishments	In immediate vicinity of salt water and industrial establishments
Cl content	.. 140	34	1144 (Mg. eq./m ² /yr.)
SO ⁴ content	.. 536	192	1230 (" " ")
Total	.. 676	226	2374 mg. eq./m ² /yr.

Tests have been made to determine how the concentration of salts in the air decreases with the distance from a seacoast. Such tests have been carried out both on the west coast of Sweden and on the North Sea coast of Holland. Both series showed clearly that the salt concentration decreases very greatly for the first few miles from the coast but extremely slowly thereafter. In the west of Sweden the salt concentration about one mile from the coast was only one-third of that at the sea, while 9 miles inland it was one-sixth and 85 miles inland it was about the same as at the nine-mile point. The Swedish findings are presented in outline in the figure on page 104.

It would naturally be of importance to have similar tests made in Karachi. Pending the result of such tests, it would appear advisable that equipment which is subject to corrosion should be installed at a distance of at least two to three miles from the shore, since conditions might be more unfavourable in Karachi than in Northern Europe.

Space Requirements

A number of investigations have been made regarding space requirements for each worker in various types of industry at the present time. Such research can provide valuable guidance in estimating the space requirements of future industrial areas. However, it must be noted that requirements may change. In England, for instance, comparisons between the older industrial establishments in Manchester and the new ones in the nearby trading estate in Trafford Park, as well as between the new plants in Team Valley and North Hillington near Glasgow, show that in general the current figures should be raised by 50 to 100 per cent when planning for the future. On the basis of recent data from England and Sweden, the net area required in Karachi for the major types of industry that need to be considered there—excluding the municipal undertakings and dock-yards—should be :—

Metals	..	17	acres per 1,000 employees
Building materials	..	62	" " " "
Food	..	8	" " " "
Textiles and clothing	..	10	" " " "
Chemicals	..	31	" " " "

To these figures should be added about 15 per cent for streets, about 20 per cent as reserves for the future, and 1 acre per 1,000 workers for recreational space. In addition, in order to arrive at the gross acreage required, 5 per cent of the total area thus calculated should be allowed for land unfit for development.

On the basis of the assumed proportional relationship between the various industries, this should average about 33 acres per 1,000 workers, or 30 workers per acre.

Since the dockyards are intended to be accommodated in the harbour area, separate figures for their space requirements are of little interest for the purpose of the Plan.

Trading Estates

A form of industrial area which in many respects is advantageous and has been given particularly extensive trial in England is the so-called trading estate. This is an area owned by an individual, a company or a public authority, and let in sections or sold, with certain services included, to industrial firms. The services offered to the renter or buyer may be gas, electricity, water, railway sidings, streets, standardized prefabricated buildings, recreational areas and shops.

This system has the following advantages. The area as a whole is more likely to be rationally planned, the industrial proprietor receives good assistance in the planning and starting of his business, all the necessary utilities are well arranged, the renter's or buyer's capital outlay is less than would be required for a completely undeveloped area, and it is easier for him to estimate his costs.

Karachi will be expected to accommodate many enterprises which have capital but lack experience in the planning of industrial areas. The facilities provided by well-arranged trading estates, such as the Sind Industrial Trading Estates Co., Ltd., should be very helpful and welcomed by such interests.

Present Localization

Existing industries in Karachi are localized to a considerable extent in the central parts of the town—Kiamari, East and West Wharves, Mauripur and the Trading Estate. The stores of the oil companies with subsidiary activities and a number of workshops which serve the ships are located in Kiamari and East Wharf. There are workshops in West Wharf as well, and the salt works is at Mauripur. The growing Trading Estate includes the cigarette factory, the Valika Textile Mills and a number of smaller plants. Outside the central area are also found the extensive establishment of Dalmia Cement Ltd., north of Drigh Road, and a group of factories at Country Club Road. Naturally, some of these industrial locations, which are well justified, should be retained and in certain cases further developed.

Distribution and Size of Industrial Districts

It is assumed that of the 400,000 persons who will be engaged in production proper (see Chapter III), 380,000 will be engaged in industries and crafts. It has been estimated that, out of these, 110,000 will work in the central part of the town and the harbour area, and 210,000 in the outer area, while the remaining 60,000—such as workers on building construction—will not have fixed places of employment. Thus a considerable concentration of industries in the central area, including the harbour, is assumed. Shipbuilding and repairs, heavy metal industries, the manufacture of building materials, and certain chemical plants are naturally assigned to the harbour area. Printing industries, light metal industries, food and textile industries and, to a great extent, various minor trades and crafts will be mainly located in the central section of the city. The industrial workers and craftsmen.

employed in the outskirts of the city are expected to be distributed as follows—160,000 in purely industrial districts, 30,000 in the centre of the Neighbourhood Units and 20,000 in miscellaneous areas, such as quarries and cantonments. In planning the distribution of the industrial areas, the aim has been to locate them along railways and adjacent to the suburban residential buildings, in order to satisfy the requirements for transport, hygiene, defence, and the like, which have been discussed prior to this.

The existing industries in the outer districts are partly located in the planned industrial areas adjacent to Neighbourhood Units, and partly in the Trading Estate, which, unfortunately, cannot be adapted to this scheme, since the ground allotted to it is already planned and partly built on, and ground suitable for residential construction is not available to a sufficient extent in the immediate vicinity.

The various Neighbourhood Units can be developed with or without industrial areas, and may thus serve either those working in the centre or those employed in industrial areas, or both. The linking up of industrial areas with Neighbourhood Units in the Plan is to be regarded mainly as an example of the flexibility of the system. It should be emphasized, however, that it has been considered desirable to site industries in all the outer districts and that, naturally, the units located near the existing railway are particularly suitable for industries.

It is assumed that the total population of a Neighbourhood Unit will be about 40,000 persons, corresponding to a working population of about 13,000. In the layout of such a unit (see page 120) the industrial area is suggested to be 100 acres. Assuming an average of 30 employees per acre, this area would provide for 3,000 workmen: the rest of the working population is assumed to be occupied in trades and crafts in the Neighbourhood Centre and in other areas of the city. It should be observed that this figure is only an average, calculated in order to illustrate the general conditions in view. In practice, there naturally will be a varying number of workmen in the different industrial areas, and the Plan also makes it possible to extend isolated industrial areas, should this be necessary for enterprises requiring much ground space.

The Trading Estate has a total area of about 5,000 acres, but in view of the nature of the ground, a great part of it to the north is not suitable for industrial development. The total ground requirements for industrial areas in the outer districts would not, however, amount to more than about 5,400 acres, assuming that there are 160,000 employees, 30 to the acre. Such a concentration of industry as would be involved in the intensive utilization of the Trading Estate is not considered advisable. On the one hand, the distance between the places of employment and the workmen's houses would be too great and, on the other, it would not be compatible with proper defence precautions. It is therefore suggested that about 1,200 acres of the area in the Trading Estate be used for industries, and the remainder employed for other purposes, such as housing. According to this proposal the number of workmen within the Estate would amount to about 35,000 and the population dependent upon them (families and secondary population) to about 140,000 persons.

Two industrial areas, lying near the railway and complying in the main with the apparent requirements, have been demarcated in Malir and Landhi, and development has already been started. They are included in the first stage of development of the Plan.

Among the industrial areas shown, those in the north-east part of the city appear best suited for industries producing soot and odours, since no construction is planned north-east of them on their leeward side.

The proposed disposition of the ground presupposes the transference of some industries in the future. For instance, the development of the Capital will crowd out the light industries along

Country Club Road as well as Dalmia Cement Ltd. In any case, Dalmia's location is not so fortunate for the Karachi Airport, as smoke and dust from cement plants interfere with flying. The pollution of the water, which will be caused by the future development of the port, would make the water in the harbour unfit for use at the salt works at Mauripur and either compel the works to find a new location or to use water directly from the sea.

The following table gives the areas and number of workers in the proposed industrial districts :—

District	Area in acres	No. of workers
Lal Bakhar	300	9,000
Moach	500	15,000
Trading Estate	1,200	36,000
Orangi	200	6,000
Babrano	600	18,000
Biti-Amri	600	18,000
Songal	600	18,000
Malir	525	15,800
Landhi-Korangi	875	26,200
Total	5,400	162,000

CHAPTER VII

RESIDENTIAL AREAS

Residential areas should be divided into units focused on centres where mosques, schools, shops, stops on public transport lines and essential public amenities are to be located. The basic unit is the Neighbourhood Unit. Within this Unit the distance between the dwellings and the centre, on the one hand, and the places of employment, on the other should not exceed a reasonable walking distance. The number of inhabitants should be large enough to make it economically possible to provide the Unit with ample public amenities and to constitute a basis for community life conforming with highly developed Muslim traditions. It is considered that as an optimum the Neighbourhood Unit should be of such size as to accommodate about 40,000 people.

The Neighbourhood Unit should be divided into Residential Units of 2,500 to 5,000 inhabitants centred around primary schools. Six to eight Neighbourhood Units together should constitute a District with 200,000 to 300,000 inhabitants. Each district should have its own District Centre.

The Neighbourhood Units should be put together in "ribbon" formation along the public transport lines. The town should not be developed by the addition of new buildings around the outskirts of the already built-up area, as has occurred in western towns during the period of industrialization. Instead, there should be a well-planned system of transport lines forming a skeleton to which built-up areas should be attached, one after another, each area extending no more than a mile from the stopping place.

Bungalows and terrace houses are assumed to be the main type of housing. They seem to suit the living conditions of the population best and are cheap to build. According to the Plan 70 per cent of the future population will be living in such houses. High density residential development is, however, provided for in central areas, thus giving the inhabitants the advantage of living near the place of employment, public amenities, etc. It is assumed that 30 per cent of the future population will be housed in blocks of flats up to 10 storeys in height.

It is further assumed that of a future population of 3,000,000 people 2,100,000 will be housed in the new outer districts of the town and 900,000 within the area of the present built-up town including Clifton and the Municipal Gardens.

The lay-out of the residential areas of a town and the location of these areas in relation to places of employment and public amenities is one of the main problems in town planning. Convenience and the economic aspect of transport are decisive factors in regard to location. In a town the size of the future Karachi, distances will be so great that public transport must be largely relied upon. The density of population in the residential areas, the distribution of these areas and the sequence in which they are built up must be considered, since the capital requirements and the running costs of the transport system are largely dependent on these factors. Excessive walking distances between dwellings and local places of employment, public amenities and stopping-places of transport should be avoided.

Furthermore, residential areas should be laid out and located in such a way that there are opportunities for the development of social group formations of a kind that will add stability and contentment to family and individual life within the community.

Density of Population, Types of Housing

The density of the population in the residential area is of special importance in connection with housing. Greater density means that more people may live near their work and close to the public amenities, and that the area of the whole town will be smaller and the town served by less extended public transport, road, water, drainage and electrical systems. Greater density of population, however, implies a transition from the traditional type of building, with mainly one-family houses of one or two storeys, to blocks of flats with several storeys. To the majority of the population such a change in housing habits will probably not be welcome. The advantages of being able to live in a one-family house or a terrace house with a private yard or garden will probably outweigh the inconvenience of longer communications. Furthermore, the building costs per unit at present seem to be considerably less for one or two-storey buildings than for multi-storey buildings, a fact which will probably apply also to the future, even though the difference in costs may decrease. It is thus apparent that the advantages and disadvantages of a dense or a dispersed population will more or less counterbalance each other, though, as far as can now be seen, one-family houses will be generally preferred. In the course of discussions with the authors of the Plan, representatives of the Government and other officials have emphasized the desirability of retaining the traditional type of house in the majority of residential areas.

Special attention should be devoted to the central residential areas. The existing core of the town will in the future continue to constitute the most concentrated working area. According to our assumptions, the central area, including the Port and the administrative part of the Capital, will contain at least half the places of employment in the town, corresponding to a total population of 1.5 million. The majority of these places of employment may be expected to lie within the present built-up part of the town, and possibly 300,000 to 400,000 workers will be employed there, corresponding to a total population of about 1 million. In view of these circumstances, there seems to be good reason to suggest a greater density of population within the residential areas lying in, or close to, the built-up part of the town. Otherwise a disproportionately large part of the population working in the centre will be compelled to live far away from their work. Since, in the future, the centre of the town is to constitute the chief cultural centre of the country, it will be especially attractive and should lead to a concentration of the population in its surroundings. From a sanitary point of view, no objections can be raised against such an arrangement, provided that the lay-outs of the areas and the plans of the houses are properly conceived. The suggestion is, therefore, to erect high blocks of flats on the greater part of the residential areas of the built-up town and also on some outer areas, for instance at Clifton Beach and on part of the area of the "Municipal Gardens" at present utilized as a sewage farm. As complete a utilization as possible would also be desirable for financial reasons, in view of the high ground values of the central areas and the comparatively costly development of the outer areas referred to. The Clifton area is an example of the latter, since here reclamation work must first be carried out. This district offers great advantages through its proximity to the sea and should therefore be intensively used.

The less densely populated residential areas should, to a large extent, be transferred to the outer districts, where work-places can be dispersed and ground values are lower.

Standard of Housing

In western countries the high standard of living for the population as a whole has resulted in a general levelling out of the differences between various classes of people so that, on the one hand, workmen have an improved standard of living and more spacious living accommodation and, on the other, the wealthier classes have been forced to live in smaller houses or flats than formerly, partly due to the difficulty of obtaining servants. In Sweden, for example, the living space in the workmen's residential quarters amounts to about 200 sq. ft. per person, while the upper classes occupy an average of 400 sq. ft. per person, or only twice as much space.

After discussions with representatives of the Authorities in Karachi, it was agreed that 200 sq. ft., on an average, should be allotted for each person living in blocks of flats, and that 5 persons, on an average, should live in each terrace house or bungalow. This implies a somewhat higher residential density in districts built up with flats than in districts with houses, which would appear to be reasonable.

Net Density

The town planning standard in a residential district can be said to depend partly on the number of dwellings of a certain given average size within an area built up with houses and partly on the size of the area allotted for schools, recreation grounds, shops, etc. In this context, only the former—including acreage for necessary local streets, small parks, etc.—will be dealt with here, while acreages for other public amenities will be dealt with under the next heading “Group Formation” and in Chapter VIII “Public Amenities”.

In order to facilitate a full comprehension of the net density in different types of housing, diagrammatic lay-outs have been drawn up for four types, viz. bungalows, terrace houses and blocks of flats with three and ten storeys. These have been made with due regard to daylight, cross-ventilation, etc. Naturally, types of housing other than those mentioned here can be used in the future, e.g. semi-detached houses, 6-storey houses, and other types of blocks of flats, but the four types illustrated should, for technical and economic reasons, be the main types to be used, and the figures given for them should be sufficient to throw light on the resulting net density. According to calculations, the net densities will be as follows :—

Bungalows	20 persons/acre.
Terrace houses	60 „ „
Blocks of flats, 3-storeys	120 „ „
Blocks of flats, 10-storeys	250 „ „

When deciding the size of purely residential areas, a net density of 200 persons per acre in the central districts has been assumed, which postulates buildings somewhat lower, on an average, than 10 storeys. The outer districts are assumed to be composed of bungalows, terrace houses and 3-storey blocks of flats, as described under the heading “The Neighbourhood Unit”.

Group Formation

Dwellings in a town are generally grouped around centres of different sizes, containing shops, handicraft workshops, places of amusement, etc., and sometimes cultural and religious institutions. In Chapter II “Cultural Background”, stress has been laid on the fact that, in the Muslim world, inhabitants of towns collect in groups around mosques and bazaars. It has also been pointed out in that chapter that the social groups are gradually broken up into higher or lower grades in industrial towns.

A pre-requisite of a rise in the cultural and material standards of the population is that cultural and religious buildings, schools and health centres should be within convenient reach of the home. The proximity to shops, handicraft workshops and premises for common leisure-time amusements increases convenience and comfort. A certain decentralization of the administration and services of the town into smaller units might also tend to create a more active community life.

In unplanned towns some differentiation of public amenities may be noted. In the planning of new towns such differentiation, for which both practical and psychological reasons can be given, is

consciously promoted. It is clear, for example, that shops providing simple everyday needs and therefore being frequently visited, can and should lie nearer the customers' homes than those carrying dearer and more specialized goods which are only occasionally purchased. It is also obvious that schools for infants should lie nearer the home than those for older children.

Various public amenities should be grouped together at centres of different grades intended to serve population groups of different sizes. This should be done for various reasons, e.g. that several public establishments can be easily visited at one time, and that, by congregating in these centres, the people may live a richer life with greater opportunities for personal contact. From the planner's point of view it is also obvious that, with a land reserve for several public amenities in a centre, a better and more flexible use of the land can be obtained than if particular reserves for the individual structures should be provided at the various places.

In the Master Plan for Karachi three different types of groups have been proposed, each one having its own centre—the Residential Unit with a population of 2,500 to 5,000, the Neighbourhood Unit with about 40,000 and the District Unit with normally 200,000 to 300,000.

The Residential Unit

The Residential Unit should be built round a local centre containing one or two primary schools, a playing field, a group of neighbourhood shops or a little bazaar, and a small mosque. The centre will require the following acreage for 2,500 inhabitants :—

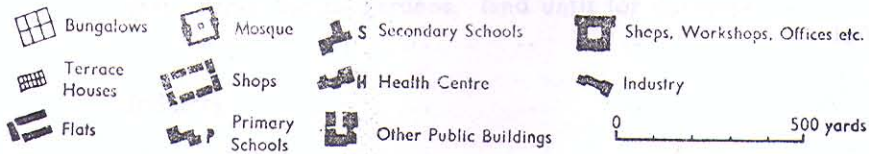
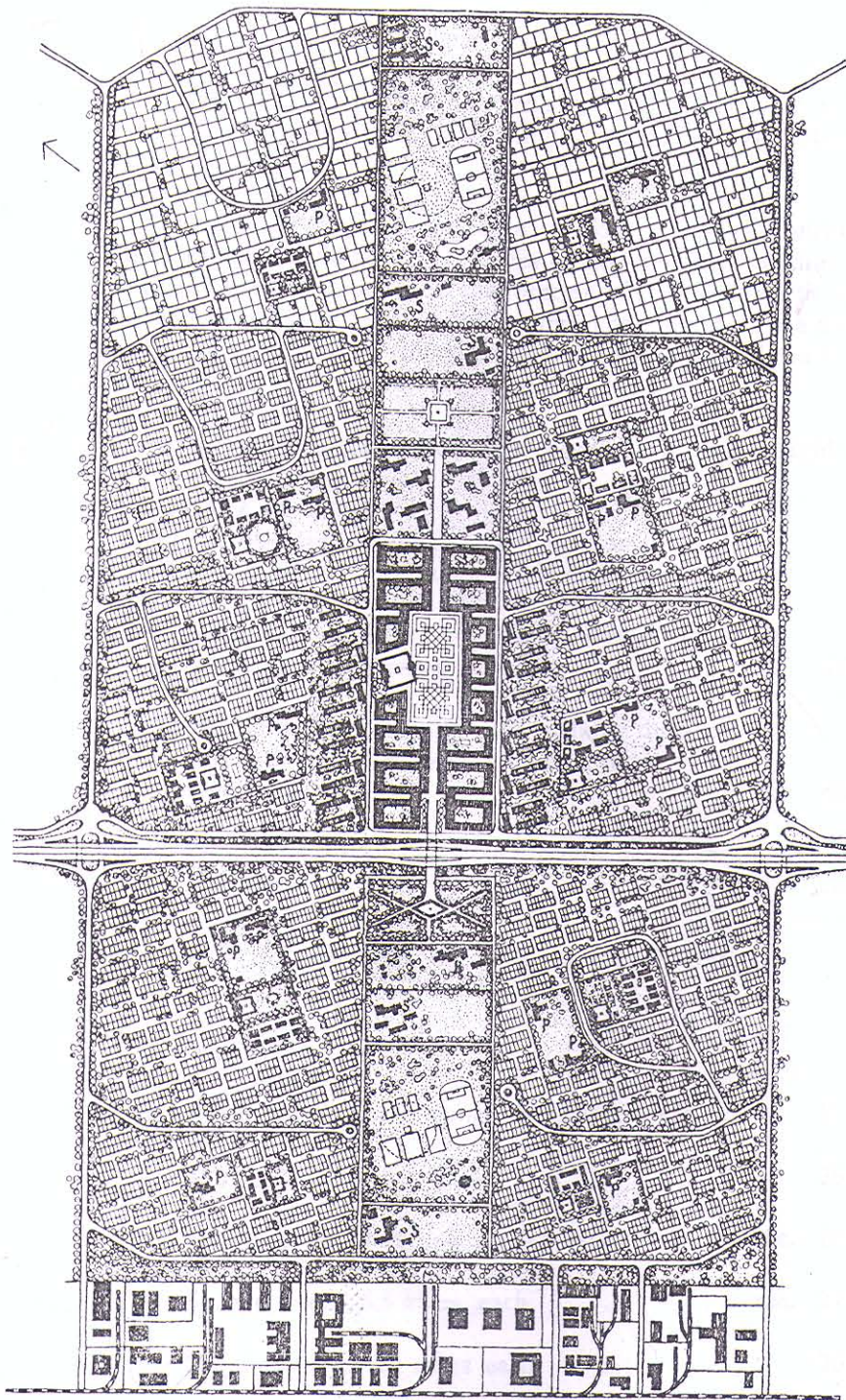
	Acres
1 primary school	1
1 playing field	2
Shops, workshops	2
Mosque	1
	—
	6
	—

The main factor determining the size of the group has been the proposed school system, which is described in more detail in Chapter VIII "Public Amenities". Two groups may be combined, making a total of 5,000 people, in order to obtain larger and better equipped Residential Centres. Even with 5,000 inhabitants and terrace house development, the maximum walking distance will be only a quarter of a mile.

The Neighbourhood Unit

According to the Master Plan the Neighbourhood Unit is intended to be the most important and most harmonious unit in the body of the city. It will constitute the element with perhaps the greatest influence on the life and customs of the people and, in many respects, on future progress. Industrial areas will be associated with the majority of Neighbourhood Units, and thus the inhabitants who do not work in the centre of the town may live their normal life entirely within the neighbourhood of their homes.

In comparison with European planning the Neighbourhood Units will be large, comprising normally 40,000 inhabitants, i.e. 8 to 10 Residential Units. The reasons are twofold. By making them as large as this, there will be a possibility of equipping them, even at an early stage, more amply with public amenities. The well-developed community sense in the Muslim world and among the population of Pakistan is also a reason for choosing such large units, and these will constitute a good basis for community life.



Lay-out in principle of a Neighbourhood Unit with about 40,000 inhabitants. Total size about 1 by 2 miles. It is made up of Residential Units with about 2,500 (5,000) inhabitants, each grouped around its local centre. The Residential Units are laid out along a core, comprising the Neighbourhood Centre, secondary schools, parks, etc. The development will chiefly be in the form of terrace houses. Close to the centre and the local railway station an area with blocks of flats is shown and further out a bungalow area. The buildings should be orientated with due consideration to solar radiation and in the direction of the wind (cf. Chapter XII). At the bottom of the picture the industrial area for the neighbourhood is shown.

Naturally, the population of the Neighbourhood Unit will vary according to their location and the temporary conditions of building—in particular, Neighbourhood Units in closely-built areas will show variations.

It should be convenient to go on foot anywhere within the Neighbourhood Unit, and no public transport should be required for communications within the unit. A reasonable maximum walking distance will depend on the location of the dwellings in relation to the city centre as well as on the density of development. After careful consideration the distance has been set at about one mile among scattered buildings (bungalows)—which will normally be found in outer areas—and three quarters of a mile in somewhat more densely built-up areas.

The approximate division of acreage in a prototype Neighbourhood Unit is set out as follows :—

Total area, 2 sq. miles			1,280 acres
Net residential land including local streets, small parks and playgrounds, and land unfit for development			
(i) Within 1/4 mile walking distance from the Neighbourhood Centre	60 acres		
(ii) Mainly within 1/4 - 1/2 mile walking distance from the Neighbourhood Centre and/or the Industrial Area	480 acres		
(iii) Within 1/2 - 1 mile walking distance from the Neighbourhood Centre	230 acres	770 acres	
	<hr/>		
Centres of the Residential Units, 16 centres, 6 acres each		96 acres	
The Neighbourhood Centre —			
(i) Public buildings, mosque, health centre, etc. ..	35 acres		
(ii) Shops, workshops, offices	35 acres		
(iii) 5 secondary schools, 3.5 acres each ..	abt. 17 acres		
(iv) 5 playgrounds, 5.5 acres each	abt. 27 acres		
(v) 2 sports fields, 10 acres each	20 acres		
(vi) Parks, formal gardens, land unfit for development	100 acres	234 acres	
Industry		100 acres	
Main road, feeder streets		80 acres	1,280 acres.
		<hr/>	

Compared with some European plans, it is apparent that the Unit has but little provision for open spaces. One of the reasons for this is the high cost of maintaining parks, due to the scarcity of

water in Karachi. Another reason is that the demand for open space appears to have been somewhat overestimated in western town planning of the last decades. This matter will be discussed in the following chapter.

A diagrammatic plan for Neighbourhood Units in the outer districts is given on page 120. In this it has been presumed that 5,000 of the inhabitants will live in bungalows, 30,000 in terrace houses and 5,000 in three-storey houses, but other combinations might occur. With closer building it follows that less acreage will be required and that walking distances will be smaller. It should be observed that the density of building should increase towards the Neighbourhood Centre, since a more central position means greater convenience and will therefore be more attractive.

An express road and a local railway line should run through each unit. Vehicular traffic should be distributed to each unit from the main road through feeder streets along its boundaries; pedestrian and cycle traffic should, on the contrary, be practically undisturbed in the central part of the unit, where the station on the local railway line should be located. Thus, as motor traffic decreases towards the centre, pedestrian traffic should increase, and vice versa. The separation of the vehicular traffic from the pedestrian and cycle traffic in this way should help to avoid the very large number of traffic accidents which are characteristic of countries with considerable motor traffic (more Englishmen were killed and badly injured in traffic accidents during the Second World War than in actual warfare). There will be the same risk of traffic accidents in the Karachi of the future, unless the town is planned with an eye to the special requirements of motor traffic. A traffic diagram for the Neighbourhood Unit is shown on page 122.

Stopping places on the local railway line should be located in the centre of the unit. In order to avoid the drawback of pedestrian and cycle traffic crossing the main road between the two halves of the Neighbourhood Unit, this inter-section should be constructed on two planes, or, before the motor traffic has become considerable, possibly with a level-crossing having a broad island refuge.

At an early stage, before there is any appreciable motor traffic and while animal-drawn vehicles are still usual, neither the express road nor the local railway should be extended. In the first stage of development the traffic may then use the feeder street along the express road reserve on the same side as the centre.

The District Unit

In order to achieve an economic size, certain institutions and establishments will need a larger supporting population than the Neighbourhood Units will offer. Among these are hospitals with special departments (Secondary Health Centres), special schools, certain types of administration, large sports grounds and certain commercial activities. On the other hand, a town with a population of three million is too large for all its functions to be taken care of in one common centre. Consequently, such establishments which need more support than Neighbourhood Units, but less than that of the town as a whole, have been grouped together in District Centres, each one serving a number of Neighbourhood Units which thus together will form a District.

As suggested in Chapter V "Trade", part of the wholesale trade ought to be located in the outer Districts, together with the storage of certain goods, and it is therefore desirable that District Centres should be supplied with satisfactory facilities for goods transport. Whether the outer District Centres should also contain shopping areas and cultural religious institutions of wider scope is uncertain, and will to a high degree depend on the quality of the communications between the District Units and the city's Central Commercial Area. As has been mentioned in different connections, it is particularly desirable that the best possible communications should exist between the various quarters of the city—in order that the city may function as a whole with all the advantages of unity. The need

for the last-mentioned public amenities in District Centres will then probably not be great, and a concentration in the main centre will be preferred. Should the recommendations regarding the construction of a perfect traffic system, including sufficient parking areas, not be followed, the District Units will have to function more as self-contained, satellite towns, in which case their centres will need to be better equipped. In the Plan, the ground reserve has been made large enough to allow for such a development.

In the Plan the new outer districts consist of Neighbourhood Units arranged in "ribbon" formation. The main reason for this lay-out is to create good communication between each Neighbourhood Unit and the city centre. A desirable flexibility is also achieved in this way, as each unit can develop unaffected by the others. The Districts, each housing 200,000 to 300,000 people, would be too large to function without internal public transport, and therefore the traffic artery serving the communications between Neighbourhood Units and the city centre should pass through the District Centre.

In the densely built-up areas of the town two District Centres have been indicated in the Plan, one beside the express road between the Capital and the Central Commercial Area, and one at Layari, located where Goth Golimar now lies.

Distribution of Population

Earlier in this chapter it has been stated that about 1.5 million inhabitants, or half of the town's future population, can be expected to consist of people and their families working in the Central Administrative and Commercial Area and adjacent areas, and in the centrally-located Port. Against this, 900,000 persons are assumed to be living in the densely developed city core which mainly corresponds to the present built-up town, including Clifton and the Municipal Gardens. About 80 per cent of these are assumed to live in blocks of flats and the majority of the rest mainly in terrace houses. The remaining 600,000 together with the balance of the population, are assumed to live in Districts with mainly low-density residential development, thus making a total of 2,100,000 in these Districts. It is calculated that about 10 per cent of this latter part of the population will live in low blocks of flats, the rest in terrace houses and bungalows.

The scheme therefore anticipates that about 30 per cent will be housed in blocks of flats and 70 per cent in one-family houses.

The distribution of the population over different Districts is set out in the following table and is illustrated on the map placed as a frontispiece to this chapter:—

				High density development	Low density development	
Present built-up area	..	..	..	600,000		
Clifton	..	..	..	110,000	90,000	
Kiamari	..	..	..		40,000	
Municipal Gardens	..	..	..	20,000	20,000	
				-----	-----	
				730,000	150,000	880,000
				-----	-----	
Capital and University areas	..	..			50,000	
Area north of the University	..	..			40,000	
Housing Societies' area, etc.	..	..		30,000	140,000	
Golimar	..	..	..		110,000	
				-----	-----	
				30,000	340,000	370,000
				-----	-----	

	High density development	Low density development	
New outer Districts :—			
“Lal Bakhar”	280,000	
“Moach”	300,000	
“Orangi”	200,000	
“Babrano”	280,000	
“Biti-Amri”	280,000	
“Songal”	280,000	
“Malir”	100,000	
“Landhi”	50,000	
“Korangi”	280,000	
		2,050,000	2,050,000
Military areas, etc.	100,000
			3,400,000

The theoretical excess of 400,000 persons above the estimated total population of 3 million has been calculated as a margin, allowing for certain flexibility in the realization of the Plan. There will thus be room for a larger population than that estimated, or for a less dense development. With a population of 3 million a complete utilization of the outer areas according to the Plan will have to be considered only if the central parts are not built up as densely as is considered possible, whereas a full development of the central areas will mean that some of the outer districts will not be fully utilized. The latter alternative appears to be the more probable.

A less dense utilization of an outer district than that provided for in the Plan would mean either

- (i) a retention of the standards of space assumed in the Plan (fewer Neighbourhood Units would then be developed in the district), or
- (ii) a rise in the standards of space or a shortening of the walking distance (the population in certain Neighbourhood Units would then be less than the number provided for in the Plan).

CHAPTER VIII

PUBLIC AMENITIES

The need for space for outdoor recreation has often been overlooked during the development of big cities. This has resulted in great difficulties which could be rectified only at enormous cost. In the Master Plan an attempt has been made to strike a happy balance between the need for green areas and other requirements.

Parks and sports areas are provided in the Neighbourhood Units and four large parks are planned in the centre of the city. The seashore should be utilized, the beaches becoming the primary health resorts of Karachi and of Pakistan. The large undeveloped areas between the residential districts may be considered as ample reserves for future parks.

Primary schools will be distributed over the Neighbourhood Unit, each school serving a population of about 2,500. The size of these schools and the walking distance to them will thus be reasonable. Secondary schools are concentrated in the centre of the Neighbourhood Unit and will serve about 40,000 people. By this arrangement they can afford to be specialized and well equipped. For higher education, areas are set aside principally in the District Centres.

Hospitals of three kinds are foreseen, viz., small hospitals in every Neighbourhood Unit, specialized large hospitals in the District Centres and a central hospital in the University Area, the latter hospital being intended also to serve part of Pakistan.

Areas for municipal administration and indoor social and cultural facilities are reserved in Neighbourhood Centres, District Centres and in the centre of the town.

Outdoor Recreation

As a result of rapid urbanization in the last hundred years the problem of recreation in the western countries has become very serious. The hasty and badly planned growth of housing and industrial districts has, in most towns, created an unfortunate disproportion between open spaces and built-up areas, and this state of affairs is now extremely difficult to rectify. Each new strip of verdure now laid out among land and buildings of high value represents an almost unreasonably great economic burden on the municipality. The modern community, profiting from this experience, now wisely tries to create, from the very beginning, the right proportions between green and stone.

Deliberations on this question, *inter alia* in England and the U. S. A., have resulted in the adoption of certain rules for the requisite green area, and these are in the main being followed in those countries at the present time. In England it has been recommended that 7 acres of open space—ornamental gardens, parks and areas for organized games—be set aside for every 1,000 inhabitants, while the U. S. A. aims at 10 acres per 1,000 head of population. It appears that, at present, open spaces in Karachi cannot be visualized to quite this extent. Shortage of water would make the upkeep of parks and other open spaces exceptionally costly and therefore limits the possibility of laying out such areas. Neither is there reason to expect the same development of athletic and sports activities in Karachi as in the U. S. A. and in large parts of Europe. Interest in sport may take, and in many cases already has taken, too large a part, especially in the life of the young people. There is a growing opinion among western planners that during the last decades the demand for open spaces has been somewhat overestimated at the expense of more serious demands. With this

in view, a somewhat more restricted standard has been proposed for Karachi than in the above-named communities, 4 acres per 1,000 inhabitants being suggested in the outer districts. It should, however, be possible to meet any future requirements for larger areas, since the undeveloped areas shown in the Master Plan will constitute a large general reserve within the city area.

Central Parks

There is a dearth of open spaces in the built-up city area. The anticipated strong concentration of work places in the central area, the intensification of working life and the large population which, even in the future, will be found in the inner town, all indicate the great need for increased acreage for recreational purposes. On the basis of existing open spaces and areas at present utilized only to a slight degree, it has been decided to lay out gradually four large parks within the boundary of the Central Commercial Area. Public buildings may also, to a certain extent, be located in these parks. One park will include Burns Gardens, the old polo ground, the Karachi Gymkhana and the park around Government House which in future will be used for some other purpose. Another park will incorporate Gandhi Gardens and the Aga Khan's Gymkhana. A third park will be formed by a stretch of parkland following, in the main, the old course of the Layari River which has been largely built up but with buildings of no great value. The fourth park will be formed from parts of Jacob Lines.

Naturally a park programme of this scope will take a long time to carry out. The parks will, however, serve their purpose even before they are completed. The most important current task is to ensure that the ground is not built over in a manner which will make it impossible to turn it into parks.

In addition to the four above-mentioned parks, there will be two in more outlying districts, viz. parts of the Municipal Gardens and the Race Course. It would appear advisable to move the Race Course to a less central position, for instance, to the Sports Centre at the north-east end of the Capital.

The establishment of a zoological garden in one of these parks might be considered.

Open Spaces in the Residential Areas

About one hundred acres have been allocated for neighbourhood parks and formal gardens, chiefly to be located in the central part of each Neighbourhood Unit. Small parks provided with seats should also be situated close to the dwellings. These latter parks would serve as playgrounds for infants.

Playing fields, combined with the playground of the primary school and devoted to the physical recreation of both children and adults, should be set aside for each Residential Unit of 2,500 inhabitants. A playing field of this type would require an area of some 2 acres. Connected with the secondary schools there should be larger playing fields, each one having an area of some 5 to 6 acres. Finally, 20 acres have been allocated to each Neighbourhood Unit for two sports fields.

These areas refer to the outer residential districts. The demand cannot be fully met in the inner residential districts. Here, higher ground values and the local conditions will cause frequent deviations from the designed layout and from the proposed allocation of areas, but, on the other hand, multi-storey development will make a large proportion of land available for communal use.

Reserves have been set aside in District Centres for open spaces, common to the whole district, in case these districts should need to be more independent than envisaged in the Master Plan.

Open Spaces in Work Areas

Wherever possible employees should be given opportunities for rest and recreation in a shady and pleasant place out of doors during the mid-day break in working hours. Parks near work places, offices and industries fulfil an important mission in this respect. This should be taken into consideration when building new industrial and administrative areas, but even where buildings already exist, attempts should be made to introduce verdure to a considerable extent.

Bathing Beaches

The greatest recreational assets which Karachi possesses are its beaches. Access to the sea, with its pure, cool air and open expanses, is invaluable to a large industrial town and should in all circumstances be preserved and fully utilized. In many towns in the western countries this has been perceived too late, and only with the utmost effort have the beaches been reclaimed from industrial, maritime or other commercial activities.

It has been suggested that practically the whole strip of shore along the open sea should be protected and mainly used for recreation. The beach has been divided into three areas, the area around Buleji, the beach from Hawkes Bay along Sandspit down to Manora, and Clifton Beach, each one intended in the future for different forms of recreation.

A National Recreational Ground is planned at Buleji, a large holiday district with bathing beaches, hotels and recreational buildings, intended in the first instance as a recreational centre for the inhabitants of Pakistan, but also as an international attraction, similar to the Riviera for Europeans and Hawaii and Palm Beach for Americans. The position of the area at a certain distance from the town proper, and its varied and characteristic natural surroundings, makes it well suited for such a purpose.

It is proposed that the long beach alongside Hawkes Bay and at Sandspit down towards Manora should be retained as an open bathing beach in more or less the same state as at present. This is the most important recreational area for the inhabitants of Karachi. An increase in its recreational value is contemplated through the addition of a sports centre.

Clifton Beach is fairly centrally situated and can easily acquire good connections with different parts of the town by an express road and a suburban light railway. It is already a popular retreat for the inhabitants of Karachi and has possibilities for development into an intensively frequented holiday centre, which can even be enjoyed for a few short hours after the day's work is finished. A small zone has been set apart, within which the facilities of sea, beach, parks and amusement places of various kinds may be combined to form a well-developed pleasure resort, primarily for the millions in the central densely built-up areas who do not have access to, or appreciate the recreational, value of, the private garden of the detached or semi-detached house.

Sports Centres

Training space and stadiums are needed for sports of different kinds—cricket, hockey, tennis, general athletics, swimming and cycling. The stadiums should be provided with considerable parking space for cycles and motor cars. It appears suitable to group the various sports activities together in a few large sports centres where about 100,000 spectators may overlook the main arena. Ground has been reserved in the Plan for three such sports centres of 100 acres each, one at Clifton, one in the University area, and one at Hawkes Bay.

Schools

Schools have one of the most important functions in residential areas. The training and instruction of children, young people and even adults exerts a considerable influence on the future economic and cultural development of a country, and progressive countries have at all times attached great weight to the educational system. In the Plan for the future development of Pakistan the building up of its educational system is also of major importance and concerns, primarily, the compulsory instruction of children.

The school system is, in addition, an important factor in the Plan for the city. Schools not only occupy an appreciable part of the ground area, but their distribution also affects the development of the traffic system and the location of housing sites. The planning of residential areas naturally depends on the system of education.

Period of Attendance at School

The period of compulsory attendance of children at school varies in different countries. In all countries, however, a strong trend towards a longer period of attendance has for some time been observed. According to the United Kingdom Education Act, 1944, children should not leave school before the age of 15, and plans are being made for them to start school at the age of 5. In the U. S. A. there are a number of different systems; in general, children attend school from the age of 6 and leave it between the ages of 14 and 18. In the U.S.S.R. school attendance is compulsory for 7 years from the age of 7 to the age of 14. In Sweden, according to a recent governmental decision on this subject, education is to be compulsory from the age of 7 to the age of 16. According to information received from the Ministry of Education in Karachi, Education Division, Pakistan intends to introduce compulsory attendance at school for a period of 8 years, starting from the age of 6. All these countries have the common ambition to provide equality of educational opportunity for all classes of the community.

From the point of view of organization, the school system seems to be fairly similar in the different countries. There are elementary schools, which may be attended for a varying length of time, supplemented by compulsory higher grade schools with a certain degree of specialization along different lines, and succeeded by voluntary technical schools, or schools providing theoretical instruction preparatory to university studies. In the U. S. A. the most favoured system seems to consist of the elementary school (6 years), the junior high school (3 years) and the senior high school (3 years): in England it consists of the primary school, which includes the infants school and junior school (7 years), and the secondary school (compulsory for 4 years), which is subdivided along three different lines of education, modern (for general schooling), grammar (for pre-university training), and technical (for non-academic professions). The two last-mentioned types of schools may be supplemented by voluntary higher education. The new Swedish educational system embraces a low grade (3 years), an intermediate grade (3 years) and a high grade (3 years). This is followed by voluntary education in secondary schools (3 years) and different types of technical schools. The educational system in the U.S.S.R. is also organized along similar lines. As regards Pakistan, it has been proposed that compulsory education shall be given in a primary school (5 years) and a secondary school (3 years), succeeded by voluntary education at a high school (3 years).

The establishment of different schools for different stages of education is related to economic, social and pedagogic requirements. Within reasonable limits larger schools imply, on the one hand, better finances and better equipment, but, on the other, a longer walking distance for the pupils and a larger number of children, which are undesirable factors from a psychological point of view. Where small children are concerned, their primary requirements are for short walking distances and a simple environment, while their requirements for highly qualified teachers and specialized equipment are naturally of secondary order. It follows that for the low grade (the primary school) smaller units,

dispersed within the residential area, are to be preferred. Older children can travel over long distances without any inconvenience, they are sufficiently mature to live amid a more complex atmosphere and should receive special instruction, requiring a highly qualified and specialized staff of teachers as well as more comprehensive and therefore expensive equipment. For these reasons secondary schools can be larger and may be located at greater distances from each other and from the homes of the children, thus serving larger districts.

Primary Schools

The optimum size of a primary school has been thoroughly discussed in different countries. In Sweden the view is held that the first three years (the low grade) should be spent in a separate unit, designed to accommodate no more than about 300 children. In England it is considered that the two components of the primary school, the infants school and the junior school, should also be separate departments. Infant schools normally are designed to accommodate 240 children, and junior schools to accommodate 320 children. In Pakistan the Education Division proposes that, in planning for Karachi, 250 children should be regarded as the normal maximum for primary schools. In this connection it has been assumed that each class should not contain more than 25 children. A primary school attended for 5 years will thus consist of 10 classes, 2 parallel classes for each year. From the point of view of town planning, there is no objection to such a scheme, which, moreover, corresponds to the recommendations now made in Western Europe.

The Education Division proposes further that, in planning for the future development of Karachi, it should be assumed that the children in primary schools will amount to about 10 % of the population. This appears to be a reasonable assumption in view of the statistics available in other countries. It should, nevertheless, be borne in mind that certain variations can be expected in the future as regards the age-structure of the population, which in any case would vary in different parts of the city. These variations will, *inter alia*, depend on the influx of adults to the city. It is, on the whole, impossible to plan a school system a long time in advance and in such a way that it will fully satisfy the requirements of the population at different periods. The figure given by the Education Division would appear somewhat high, but is wisely chosen in this connection, since the ground reservations made should be ample.

The assumptions made above (250 children per primary school, corresponding to 10 % of the population) means that each school will serve a population of 2,500. This population will thus form a group, which must be given due consideration when plans are being drawn up.

According to Swedish standards, pupils attending a primary school should not have to walk more than about 1/2 mile. In the United States a walking distance of between 1/4 and 1/2 mile is usually recommended. Normally there would be no reason for deviating from similar requirements in Karachi, except where the density of the population is very low and the walking distance might have to be longer in order to obtain the number of pupils required for a school.

Supposing the density of the population to be the same as assumed in the Plan, the walking distances to the primary schools will, in actual fact, meet the requirements stated above even for the less densely populated areas and even if two such schools are located close to each other.

In calculating the space required for a primary school one should, to begin with, choose a lay-out of the school buildings which will satisfy modern demands for ventilation and light. Further, the space allotted for playgrounds should be ample. The proposal of the Education Division that each school should be allocated 1 acre of ground corresponds approximately to present-day requirements in Western Europe. This allotment of 1 acre should be supplemented by a further 2 acres to be used

as a playing field, which would also be sufficient to provide for the needs of the younger school children who would only play games requiring little space.

Secondary Schools

The number of children attending a secondary school should vary between 400 and 600. In Sweden it is considered that such schools ought not to accept many more than 400 pupils. In England it is considered that a secondary school should not be subdivided into more than 3 parallel sections, which would mean a total of about 450 children, if higher complementary instruction is not provided. If this is provided, the number of pupils may be increased to 550. There are, of course, considerably larger schools, but their size is then due to conditions lying beyond the scope of the school system, such as, for instance, the availability of building sites. It is assumed that identical standards can be applied in Pakistan.

The Education Division assumes that, when planning for the future, one should be able to count upon about 5% of the population attending secondary schools. Taking into account the death-rate and the number of pupils who will pass on to private and special schools, the assumption that the number of pupils attending ordinary secondary schools will be half the number attending primary schools appears justified.

A walking distance of up to 1 mile should be acceptable for pupils of secondary schools. In Sweden $\frac{3}{4}$ of a mile is regarded as the maximum, but it should be observed that Swedish children are younger when they begin to attend a secondary school. Several secondary schools of the size mentioned above can be built within a walking distance of 1 mile, even in areas where the density of the population is low.

The distribution of secondary schools is intimately connected with specialization in education. If, as in England, instruction is differentiated at an early stage, and the different lines of education are assigned to different schools, a larger population group is required to obtain a uniform school group. If, as in Sweden, specialization is put off until the last year at secondary school, and if it is not carried too far, the district served by the school will be smaller.

It is perhaps too early to state at present which method Pakistan may be expected to follow. One might, however, say that, if the requirements relating to a more specialized system are satisfied, it will always be possible to make arrangements for a less specialized system. The distribution of children between the different secondary schools has therefore been made mainly in accordance with recent English practice, i.e. $\frac{3}{4}$ in modern schools, and $\frac{1}{8}$ each in grammar and technical schools.

Assuming that every class will contain 30 pupils, i.e. the maximum number approved by the Education Division, a modern school with 540 pupils and a three-year course will have 6 parallel sections. These schools should not be made larger.

Grammar and technical schools, where the last 3 years of compulsory training are supplemented by 3 years' voluntary attendance, will thus have 6 classes; this will only allow for 3 parallel sections, if calculations are based on 540 pupils. It has been assumed here that practically all the pupils of the secondary schools will pass on to the higher voluntary section.

If we assume that $\frac{1}{8}$ th of the pupils will attend grammar or technical schools, one group of schools will consist of 3 modern, 1 grammar and 1 technical school. If we further assume that 5% of the population will attend secondary school, then such a group of schools would theoretically serve a population of 43,200.

A group of secondary schools corresponding to a population of about 40,000, previously denoted the Neighbourhood Unit, may generally be located within an area where reasonable requirements regarding walking distances can be met.

In this connection the desirability of also attaining a certain centralization of modern schools by concentrating two or three schools in the same vicinity should be mentioned. It will then be possible to vary somewhat the instruction and to give individual liberty of choice between the schools.

Requirements as to the size of the school grounds for a secondary school differ widely in different countries. These variations, however, chiefly concern the space to be allotted to playing fields. Requirements as to the ground space of the school itself and of the attached playground vary very little; as a rule 30 sq. yds. per pupil or about 3.5 acres for a school with 540 pupils are required. This standard ought also to be maintained in Pakistan.

The requirements for playing fields depend on the views held in different countries about physical culture and on the general character of the landscape and the climate, which will affect the provision and maintenance of playing fields. English requirements, 150 sq. yds. per pupil for secondary schools, would seem to be the highest; in Sweden only 50 sq. yds. are provided. Since it is probable that, in Karachi, the maintenance of lawns, to give an example, will always be very expensive owing to climatic conditions, requirements for playing fields ought not to be too high. Physical fitness may be secured even with limited space. It is proposed that a secondary school should be allotted a playing field of at least 5.5 acres, corresponding to slightly more than 50 sq. yds. per pupil.

Nursery Schools

For a long-term policy it would seem advisable to assume that a certain number of nursery schools will be required. This requirement arises partly from a growing demand that children should be prepared for their compulsory attendance at school, and partly out of the wish that children should be cared for during the day so that mothers can get more time for other interests or work. If primary schools are distributed over the residential areas in the way suggested, and grounds of the size proposed are reserved, it ought to be possible, without causing any inconvenience or requiring any additional ground, to build nursery schools attached to the primary schools. For this reason it does not appear necessary to make special reservations for nursery schools.

Special Tuition

Special tuition should be provided for children who, by disease or disablement, are prevented from attending the ordinary school classes. As far as possible such tuition should be provided in special classes but at ordinary schools. Serious cases will nevertheless require special schools in the future. It is obviously impossible to calculate precisely the requirements for such schools, but it may be assumed that they will serve very large groups of the population and that they cannot, in general, be located near the homes. They will probably have to be boarding schools, and the determining factor for their location will be easy accessibility to visiting relatives.

Although it is assumed that a certain training for different professions will already have been received at the technical schools, vocational training will in future have to be given by special schools preparing pupils for the professions, applied art, administration, office work, and so on. Thus the Education Division states that 10 Government Technical High Schools will have to be established within the next 10 to 15 years, each school to receive 500 pupils, one hundred of whom to be accommodated as boarders, if desired. It is impossible to foresee the scope of such a development. It appears clear, however, that these schools will be so highly specialized and so few in number that they will have no direct connection with the residential areas. On the other hand, the above-mentioned statement

of the Education Division clearly indicates that these schools should not be concentrated in one location for the whole city area. Since technical instruction is closely related to industry, these schools may profitably be situated near the industrial areas. For similar reasons, art schools of different types should be connected with or located near the cultural centres of the city, nurses' training schools should adjoin hospitals, and so on. In the Plan, reservations should therefore be made for schools of this type in places where they can easily maintain contact both with the larger residential areas, and, as far as possible, with certain special areas, and where means of communication to the city area are available. In the outskirts of the city the District Centres should provide suitable sites for these schools. In the central part of the city their location will be more dependent on local conditions. In the Plan certain locations are only approximate. The total number of such special schools of various kinds is estimated at 30. The ground space required may be assumed to be equal to that required for a normal secondary school, i.e. about 9 acres.

In addition, private schools of different types must be expected to be established in the future, for example, schools for children of different religious creeds. Such requirements cannot, however, be estimated, and one must assume that satisfactory reservations of ground space will be available when detailed plans are worked out.

Finally, there is the question of providing for the voluntary free-time education of adults. In this connection it should be assumed that instruction in simple subjects — reading, writing, arithmetic — may be given by holding evening classes in primary and secondary schools. It is obvious, however, that the desire to obtain more profound knowledge on a certain subject should be stimulated. It would therefore appear desirable that adequate facilities be provided within comfortable walking distance of the individual homes either attached to some technical or grammar school or situated in the centre of the Neighbourhood Unit. The space required is comparatively insignificant, but should receive attention when details are planned.

Hospitals and Health Services

Hospitals and health services will have to undergo considerable development, if economic and social conditions are to be improved to any appreciable extent. The recommendations made in the Report of the Health Survey and Development Committee 1946 (The Bhoré Report) have been accepted as a basis for the future organization of hospitals and health services. The Master Plan for the future Karachi also takes into account these recommendations and, by way of an introduction, a summary of the long-term programme contained in the Report is cited here:—

"The Three Million Plan

21. The district health organisation will have as its smallest unit of administration the *Primary unit*, which will normally serve an area with a population of about 10,000 to 20,000. A number of such primary units (about 15 to 25) will together constitute a *secondary unit* and a varying number of the latter (about 3 to 5) will form the *district health unit*, the designation by which the district health organisation will be known. At each of the headquarters of the district, secondary and primary units will be established with a Health Centre as a focal point from which the different types of health activity will radiate into the territory covered by each type of unit. The *District Health Centre* will possess general and special hospitals with a total bed strength of about 2,500 and all consultant and laboratory services required for the diagnosis and treatment of disease on up-to-date lines. The administrative staff of the district health organisation will be located here and will exercise supervision over the district as a whole. Similarly, the *Secondary Health Centre* will be provided with hospital accommodation of about 650 beds and with equipment and other facilities on a generous scale, although not up to the standard of the District Health Centre. The administrative

staff of the secondary unit will be attached to the Secondary Health Centre and will exercise supervision and control over the primary units included in it. The *Primary Health Centre* will have a 75-bed hospital and health administration over the area included in the primary unit will radiate from this Centre."

The Plan presented above is in broad outline and will, in every single case, have to be adapted to local conditions, such as the size of the district and the distribution of the population. This has been pointed out in the Bhore Report, which emphasizes particularly that attention must also be paid to other types of administration. Incidentally, the total population of the district theoretically outlined in the Bhore Report corresponds to the assumed future population on which the Master Plan for Greater Karachi has been based.

The carrying into effect of the programme contained in the Bhore Report would mean that 5.67 hospital beds would be placed at the disposal of every 1,000 inhabitants of the city. This implies an unprecedented development of Pakistan's health services. Nevertheless, from a long-term point of view an even more far-reaching development might be imagined. Since the requirements for ground space for health services are very small compared to the acreage required for houses, schools and productive activities, and since it might be difficult to find new, suitably located sites for hospitals at a time when a further improvement in the standards of living might be expected, it would seem advisable to reserve an acreage larger than the one demanded in the Bhore Report. This would allow for a future reorganization involving a different distribution of the hospital accommodation between the three units. In Sweden, plans have been made for developing hospital services until 17 beds became available for every 1,000 inhabitants; in South Africa 10 beds are allotted for every 1,000 inhabitants.

In the Bhore Report the primary unit includes no more than 20,000 inhabitants served by a hospital with 75 beds; the secondary unit includes 600,000 inhabitants served by a hospital with 650 beds. In the Master Plan the corresponding units are the Neighbourhood Unit with 40,000 inhabitants, and the District Unit with 200,000 to 320,000 inhabitants. In some cases the districts are somewhat smaller. Retaining the same distribution of the number of beds between primary and secondary centres as in the Bhore Report, a Neighbourhood Unit would contain a hospital with 150 beds (Primary Health Centre), and a District Centre a hospital with, normally, between 220 and 350 beds (Secondary Health Centre).

During the first stage of development a point should be made of having ample hospital accommodation available in the Neighbourhood Units, since, in view of the habits of the population, it appears important that hospitals and health services should form part of the familiar, everyday surroundings. On the other hand, it will for financial reasons, be difficult to accomplish at once a far-reaching specialization of hospital services. As long as much remains to be desired in the way of public transport, it will also be advantageous to have hospitals available within walking distance from all parts of residential areas. The Director of Health has declared that it should be possible to adapt the programme of the Bhore Report to the grouping scheme of the Master Plan. Today, however, hospitals with so few beds are not regarded as advantageous by Health Authorities in the western countries, since larger units afford possibilities for better treatment. Consequently, it is proposed that the ground reservations in the District Centres (Secondary Health Centres) should be made large enough for hospitals with 600 to 1,000 beds, i.e. about three times the capacity mentioned above, which will render possible either a total increase in hospital accommodation within the city area or an organization with half the number of beds (about 75) in Primary Health Centres and a retention of the former total capacity. In the Neighbourhood Units a certain number of beds should always be available for confinements, accidents, and the treatment of chronic diseases.

Since, in this case, the District Health Centre not only constitutes the centre of the Health Organization of the city but also the University Hospital of the capital of the country, it would appear reasonable to anticipate the possibility of expanding it to reach an even greater capacity than that foreseen.

in "The Three Million Plan". The requirements this would entail cannot be accurately estimated before hand, but a ground reservation for accommodating 3,500 instead of 2,500 beds is proposed.

The large hospital units in the District Centres and the central hospital are each planned to contain, in addition to a general hospital, several hospitals for epidemic and mental diseases, etc. and a sanatorium for tuberculosis.

An organization to administer public medical assistance and ensure public health and hygiene will be attached to each Health Centre. In this connection the Primary Health Centres will be of particular significance, since their first function will be to maintain direct contact with the population. It is therefore imperative that they be located centrally in the Neighbourhood Units. The Secondary Health Centre and the District Health Centre need not meet such requirements. Where these centres are concerned it is, however, of great importance that they be situated within reach of public means of transport, so that the groups of population that they are to serve will be able to reach them within the shortest possible time. It is assumed that the Nurses Training Schools, and schools for other members of the staff, will be attached to Secondary Health Centres, which implies that they, too, should be within easy reach.

The requirements for ground space for the establishment of health services will depend on the type of construction favoured. The size of the hospitals will also affect the average ground space per bed—small hospitals requiring comparatively more space. In Sweden, for instance, where, in general, compact multi-storey hospitals are being built, the minimum requirement is fixed at 120 sq. yds. per bed. In Karachi, considering the climate and the local building traditions, one should anticipate a much higher figure, especially since both the Health Organization and the training centres are to be attached to the hospitals. About 240 sq. yds. per bed (corresponding to 20 beds per acre) are proposed here, which would necessitate a provision for the following ground space for the different centres:—

(i) in the Neighbourhood Unit (Prim. Health Centre)	150 beds	7 acres
(ii) in the District Centre (Sec. Health Centre)	600 to 1,000 "	30-50 "
(iii) Central Hospital	3,500 "	170 "
Additional beds for the Faculty of Medicine of the University	30 "	200 "

As pointed out above, the building up of an organization of this scope will take a long time. This has also been emphasized in the Bhoire Report, which discusses in addition a short-term programme implying an increase in hospital accommodation by adding 1.03 beds per 1,000 persons for a period of ten years. There is no reason why the Plan, which deals principally with the allocation of sufficiently large and suitably located reservations, should go into the details of this programme. There are, however, other considerations related to the initial building-up period which the Plan must take into account. This refers particularly to the utilization of existing hospitals, nursing homes, etc.

Of the two largest hospitals now existing in the city the hospital in the centre can hardly be enlarged to any appreciable extent, since there are no reserves of ground space. On the other hand, the hospital in the Karachi Cantonment might be enlarged if the Ministry of Defence, which has the ground at its disposal, should consent to the utilization of the adjoining undeveloped areas for this purpose. If this is not possible, both hospitals must be retained as Primary Health Centres, and a Secondary Health Centre for the population of the inner quarter of the city must be established somewhere else. For this purpose ground space has been reserved in the Plan, but the future utilization of the existing small hospitals connected with health services cannot be gone into in detail. These

hospitals should be utilized along the general outlines drafted in the Plan as far as this is considered necessary when detailed plans are drawn up. Reservations have also been made in the Plan for a possible further extension of the Sanatorium in Country Club Road, intended to be used as an anti-tuberculosis centre.

For the time being, the leper colony at Mangho Pir is to remain where it is, and it is hoped that the colony will eventually become superfluous.

It is proposed to utilize an area in the Malir district for a mental hospital. This will be spacious enough to accommodate 200 beds and has been located in this area in deference to an expressed request, so that the patients may be employed in agriculture. The site marked on the map should be regarded as approximate only.

Mosques and Burial Grounds

Mosques

It is assumed that mosques will be sited in each Residential Unit and Neighbourhood Unit, but it is doubtful, for reasons given in Chapter VII "Residential Areas", whether any mosques serving a whole district should be built in the District Centres. Mosques intended to be used on important holy days should be located mainly in the central area, and the most important of these should be located in the Capital, as mentioned in Chapter IV. In the detailed plan, places should also be assigned for mosques in the different working areas.

Burial Grounds

Cemeteries occupy considerable areas in both Muslim and Christian towns and those intended to serve the centrally situated, densely populated areas of large cities are generally located at some distance from the built up areas. In the Plan three large reserves have been so located. In the outer areas the burial grounds should preferably be small and located close to the Neighbourhood Units. It is proposed that they should be placed in what are called Undeveloped Areas, and that each one should serve one or more Neighbourhood Units. The acreage of a burial ground for a Neighbourhood Unit with a population of 40,000 will not be large. Re-use of the ground after a certain period must necessarily be assumed. In the long run, 20 acres should be sufficient in view of the anticipated lower death-rate in the future. If twice this area, or 40 acres, is reserved, this should be fully adequate.

Various Amenities

Indoor Social and Cultural Facilities

The biggest theatres, the most modern cinemas, the finest concert halls, the most fashionable restaurants and the best art exhibitions will be found in the central area.

Similar facilities will, however, also be required within the residential areas and should be concentrated to the Neighbourhood Centres, since these should be richly equipped for cultural activities, social intercourse and pleasure. Premises which would meet the local needs for these activities should be erected on the main street or in the main square, either individually or grouped together in community centres, the latter being more common in modern western town planning. The community centres should contain assembly rooms, small rooms for meetings and classes, a library, art exhibitions, workshops for classes in arts and crafts, and citizens' advice bureaus. With the raising of the cultural standard of the population, access to such premises will be of the greatest significance. It is important that the environment of the outer residential areas should not be culturally impoverished.

Municipal Administration

In step with the growth of the town and the rise in the standard of living, implying better and more comprehensive public services, the administration of the town will expand considerably during the realization of the Master Plan.

The administration can with advantage be decentralized to a certain degree. Thus it is recommended that law courts, local police stations, registrars' offices, etc. should be established in Neighbourhood Units, in the centres of which ground should be reserved for a municipal building. The locating of a small part of the administration in District Centres may also be considered, e.g. law courts, other premises for the public services.

The central part of the administration will, however, be the most important and a very large extension of this must be foreseen. It should therefore be considered whether the present administrative buildings at Lower Bandar Road could form, in the future, the core of a considerably larger administrative centre, or if ground for an extension of the administrative headquarters should be reserved at another site. In the latter case it appears that, from the point of view of communications, a better site in the future would be in the neighbourhood of the inter-section between Bandar Road and the proposed Golimar-Malir transverse express road, where the land has not yet been so intensively used as that around the Municipal Building.

CHAPTER IX

URBAN TRAFFIC

The advantage of big cities, and the very reason for their existence, is the manifold opportunities for contacts and connections they offer. Full use of these opportunities, however, depends on the efficiency of the traffic system.

Efficiency in modern traffic requires high speed and safety. This is mainly obtained by separating the different kinds of traffic. Thus, on the main roads, pedestrians, bicycles, motor cars, local railways, etc. should each have their own lanes. Crossings should lie as far apart as possible and should be grade-separated on main roads.

The main load of public transport should be taken by a suburban light railway system located at ground level in the new sections of the town and principally as an underground or elevated railway in already built-up areas. Rapid bus lines and the main railway system should also carry part of the suburban traffic, and, in the first stages, even the whole of it. Local bus lines should serve the local traffic in the centre of the town.

Economy of public transport in the future will depend mainly on two factors, both of which are decisively influenced by planning:—

- (i) transport should be concentrated by locating residential areas and places of employment close to a limited number of transport lines, which would then be used almost to the maximum of their capacity.
- (ii) Traffic speed should be high to enable every single transport unit to be used to its full capacity, reducing the number of units necessary and thus the number of employees.

The gradual development of the traffic system during the growth of the town is dealt with under Chapter XIII, Stages of Development.

As a city grows, travel frequency increases. Greater distances between residential areas at one end of the city and working areas, shops, recreational facilities, etc., at the other, increase the need for travel.

The town planner might deliberately locate working areas, shops, etc. near residential areas, thus decreasing the necessity for travel. But, even if such measures are taken, there will still remain a wide demand for transport. A big city offers to industry the advantage of a large labour market, provided that means of internal transport are available for workmen to reach their places of employment from any part of the city, without undue difficulty. Another great advantage is the centralization of certain functions—concentration of shops in the centre offers shoppers the choice of a wide selection of goods, and such concerns as mercantile and administrative offices profit from close contact with each other. Similarly, the crowding together of amusement places in the centre of all big cities is an attraction in itself. Consequently, it would be fundamentally wrong to insist on a rigid decentralization policy simply to avoid the introduction of traffic problems. The functions of a big city must necessarily create a large volume of traffic, and it should be the planner's task to provide for the free circulation of traffic.

Passenger transport in a city can be provided by public means of transport—buses, trams and local railway systems—or by private vehicles, such as motor cars and bicycles. Public transport

has the advantage of requiring less space per passenger than individual transport, especially in comparison with motorcycles and cars; it is also considerably cheaper. Ratios of space requirements per person-mile-hour of different means of transport¹ are given below:—

Means of transport	Comparative figure
Pedestrians	16
Bicycles	15
Motorcycles	28
Motor-cars	70
Buses—	
32 seats	18
55 „	12
150 „ (with trailer)	6
Tramways (two cars)	4
Metro, Paris	2
Local railway, U. S. A.	1

According to this survey, motor-cars take up the most traffic space, and, in particular, require large areas for parking.

In the central sections of a city, where land is in great demand and existing constructions often are great obstacles to the widening of streets, development of traffic junctions, etc., the public means of transport are of special value. This applies in the first place to local railway systems which have the least space requirements. In the bigger cities the only possibility of avoiding a traffic paralysis has, in many cases, been the construction of a local railway net on a separate road-bed which, by means of tunnels and viaducts, crosses at different levels the other streams of traffic.

On the other hand, motor-cars and bicycles make door-to-door travel possible, and motor-cars generally offer a more comfortable means of travelling. A raised standard of living necessitates a free use of these vehicles in city traffic. Furthermore, lorries are essential for the transport of goods; in most cities they constitute a very large part of the total traffic.

A survey of traffic intensity in a number of countries shows that passenger traffic as a rule grows in proportion to the income per head of population—and the figures for goods transport generally show the same tendency. The number of motor cars in Pakistan in 1950 has been reported as 0.35 per 1,000 inhabitants. Comparisons with other countries would indicate that, by the year 2000, 10 per 1,000 might be regarded as normal, with the standard of living assumed for Pakistan by that time. The average standard in Karachi will probably be substantially above this level, which would be reflected in a greater number of motor cars than in the rest of the country. Nevertheless, since the area surrounding Karachi is not yet built up, the need for motor cars will probably be limited for a long time to come. A well-developed local railway system would have the same retarding effect. It should also be taken into consideration that, as the tropical and sub-tropical countries become industrialized and consequently their standard of living raised, other and lighter vehicles than motor-cars may become popular in climates where protection against cold and rain, when travelling, is not needed to any great extent. Recently,

¹ K. LEIBRAND: "Aufgaben des Verkehrsingenieurs", Schweizerische Bauzeitung 1951:25.

motorcycles especially constructed for city traffic—so-called scooters—have come into use even in big cities with a severe climate.

It is proposed in the Master Plan that there should be a certain decentralization of places of employment, but also a strong concentration of commercial and industrial enterprises in the inner city. For the solution of the traffic problem there should be, first of all, a well-developed local railway system, supplemented by bus lines, and a system of express roads and major roads. Even in a simpler form the roadways will be very important in the immediate future, and, when fully developed, they will meet the very great demands of motor traffic.

Street Traffic

In modern town-planning one of the most essential factors is the lay-out of streets for different kinds of traffic. Only by differentiating the traffic will it be possible to avoid congestion and reduce the many traffic accidents characteristic of almost all big cities with multipurpose streets. Three particular types of streets may be distinguished in this respect:

- (i) Express Roads, exclusively for fast moving traffic mainly between the different districts of a city.
- (ii) Feeder Roads or—as they are classified for the central areas—Major Roads, branching off from the express roads and “feeding” the local areas.
- (iii) Local Streets, serving the adjacent buildings and establishments. These streets will have little through traffic and consequently the traffic flow will be small and slow, a factor of great importance for safety.

Since most of the traffic will follow the express roads and the feeder or major roads, the local street system will require less space than in a lay-out with little or no traffic differentiation. Consequently, in spite of the high standard necessary for the main traffic arteries, a differentiated system of roads will often prove cheaper to develop than a network of roads laid according to old-fashioned principles. It will in any case prove more economical if the variable cost of traffic (which depends mainly on the length of time it takes to travel a certain distance) is taken into account. This system will allow for greater speed and yet guarantee greater safety.

The required standards will naturally depend on the density of the traffic, and it is difficult to say how this will develop in Karachi in the future. On the basis of the assumptions made regarding certain other standards it has been estimated, however, that the future traffic of Karachi will reach at least the present volume of the traffic in the large Italian cities. There, a system of the type described above, with first-class express roads, major roads and local streets, has been introduced, although local conditions, and in particular the high value of existing buildings, stand in the way of a rapid development of this system.

In the outer, undeveloped areas there would be no difficulty in introducing a differentiated traffic system, but in the city centre much the same difficulties have to be met as in big American and European cities. It follows that every change in the existing conditions, viz. the building of new houses the re-planning of streets, and the like, must be made in accordance with a long-term plan.

Express Roads

The express roads, reserved for fast moving traffic, should have the following characteristics:—

- (i) They should not have to absorb the traffic discharged from adjoining blocks, so that there should be no stationary or parked cars on these roads, nor any access to them from adjoining property.

- (ii) Separate lanes should be provided for the different types of traffic (railbound vehicles, motor-cars, bicycles, pedestrians), and traffic going in different directions should, as a rule, be separated by protective strips.
- (iii) Crossings should lie as far apart as possible ($1/4$ to $1/2$ mile in the centre, 1 to 2 miles in the outer districts) and should be grade-separated.

In the Plan express roads are laid out as a system of radial roads diverging from the city's central area, each serving a district of 200,000 to 300,000 inhabitants. In order to reduce traffic traversing the central area and to facilitate traffic between the different radial roads, these are interconnected by two ring roads. In principle it should be possible for the traffic to follow an express road to within about half a mile, or less, of its destination.

If, at some future date, this primary system should become inadequate, the radial express roads can be duplicated by other express roads running through the unutilized ground reserves between the different areas of the city. Certain express roads will serve other purposes, in addition to connecting the centre of the city and its periphery, i.e., they will act as long-distance traffic arteries. These roads have been marked in the Plan. Thus, from the centre of Karachi one express road, passing through unutilized areas, will lead to the future seaside resort Buleji, two will lead to Baluchistan, and one to Hyderabad (Sind). The map at the beginning of this chapter shows the entire system.

It is suggested that the express roads should be built with two carriageways carrying three lanes of traffic each, plus sidewalks, and special lanes for bicycles, where required. The roads should be divided by means of continuous protective strips, as shown on the opposite page.

The express roads should run through the central area and will thus affect areas which are now built up. In several cases this will mean breaking through the present development and the construction of expensive viaducts, etc. Nevertheless, in the central area the express roads will carry their maximum load and there, in particular, the standard proposed in the Plan should be strictly observed.

Feeder Roads—Major Roads

The feeder roads will form the connection between the express roads and the network of local streets. If possible, feeder roads should not be obstructed by traffic discharged from adjoining blocks or by parked vehicles, but here the requirements are not so rigorous as for the express roads. In the outer areas the ground reservation should ultimately allow for a four-lane carriageway.

In the city centre the function of this type of road will be undertaken by major roads, which will always have to carry rather heavy traffic, since these roads will have to serve for the distribution of traffic from the express roads to the local streets. As the distances are necessarily great between the crossings and between the accesses to the express roads, the major roads will also serve the inter-area traffic within the centre.

The major roads will often have to follow existing roads and will include some of the main shopping and commercial streets, such as Bandar Road and McLeod Road. They will be open to all kinds of vehicles and must be constructed so as also to allow for a concentrated pedestrian traffic. Parking will generally be permitted on the major roads. Their cross-sections and widths will depend on the type of activity carried on in their vicinity and in the buildings now bordering them. It is impossible therefore to give their widths and describe their cross-sections at every

The subway underneath the express road is planned so as to make the viaduct as short as possible, and this type of intersection occupies less space than the flyover.

The "trumpet" is proposed for places where the major road joins the express road, but does not cross it. It requires less space and, from the point of view of the traffic, the layout is preferable to the half cloverleaf.

The "roundabout" is the normal type of intersection between two major roads. It requires a great deal of space, however, and where land is too valuable for applying this type the intersection between two major roads should merely be provided with traffic signals. If the traffic turning to the right is considerable in the one road, only, and not in the other, three-phase traffic signals should be used, and if the traffic turning to the right is heavy in both intersecting roads, the traffic signals should be four-phase.

Capacity

When the sections and intersections of traffic arteries are planned in detail, the amount of traffic they are required to carry must be considered. The maximum capacity of a lane of motor traffic depends on a variety of different factors, such as the proportion between passenger cars and lorries, the width of the lane, the visibility, the road profile. In view of this it is impossible to give any generally applicable figures regarding the capacity of a lane of motor vehicles. Experiences in the United States,¹ however, seems to indicate that the basic capacity of a two-lane road is a total of 2,000 passenger cars per hour, i.e. 2,000 passenger cars is the maximum number that can pass a given point on a lane or a roadway in one hour under the most ideal roadway and traffic conditions. The basic capacity of a multi-lane road with more than three lanes seems to be 2,000 passenger cars per lane per hour.

The practical capacity, i.e., the maximum number of vehicles that can pass a given point on a roadway or in a lane in one hour without the traffic density being so great as to cause unreasonable delay, hazard or restriction to the driver's freedom to manoeuvre, is only about three-quarters of the basic capacity. Sharp curves, limited visibility, a great proportion of lorries, etc., can further reduce these capacity figures very appreciably. It should be borne in mind, however, that, in practice, the principal factors limiting the capacity of the roads are the shape and the number of crossing rather than narrow cross-sections.

It is proposed in the Plan that, once the traffic arterial system has been completed, express roads should have six lanes. Assuming the road to have first-class cross-sections and profiles, and that about 20 per cent of the traffic will consist of lorries, the practical capacity of a six-lane road in Karachi would not exceed 4,000 vehicles per hour in each direction.

A "thirtieth-highest-hour-density" —the hourly traffic volume that is exceeded only 30 times a year—of 4,000 vehicles per hour in each direction corresponds to 50,000 to 80,000 vehicles per day in both directions, according to the type of traffic using the road.

The intersections of express roads should, on completion, be grade-separated, if they are to be used to their full capacity, but, during the earlier stages of construction, roundabouts or intersections controlled by traffic signals may be used. It is even more difficult to indicate general capacity figures for intersections than for simple lanes of motor traffic. Under ideal conditions the roundabout shown in the figure opposite might, however, in a weaving section have a maximum capacity of about 2,000 vehicles (excluding cycles) per hour. By applying improved methods, e.g. wider radii

¹ Highway Capacity Manual, U. S., Department of Commerce, Washington, 1950.

and additional lanes, this capacity might be appreciably increased. Under ideal conditions intersections controlled by traffic signals have a basic capacity of 1,250 passenger cars per 10 ft. of width per hour of green light. The intersection with three-phase traffic signals shown in the figure opposite would, under normal conditions, have a total capacity of about 2,500 vehicles per hour.

Parking Areas

Traffic returns and studies of parking habits have shown that even in big cities, where the traffic is heavy, the number of temporarily stationary or parked motor-cars considerably exceeds the number of moving cars. In Sweden it has been found that only 10 to 20 per cent of the vehicles in the streets are in motion at midday. In the city of Los Angeles, where, per head of population, probably the greatest assembly of motor-cars in the world is to be found, about 50 per cent of the central area is used for parking, and even then this area has proved to be inadequate.

In Karachi the increasing demand for parking space can be met, to a certain extent, by providing parking areas in the widened streets, for example in the proposed major roads. In this way, however, only a slight proportion of the future needs will be satisfied. The building regulations for the central areas should therefore contain the provision that certain parking facilities should be provided on private ground in connection with new development. This would apply particularly to enterprises causing a great demand for parking, such as hotels, department stores, large offices, etc. In addition, ground should be reserved for specific parking lots in the most central locations and near the traffic arteries. At a later stage these lots may be developed into multi-storey parking garages. Experiences in the U. S. A. have shown that the parking fees collected may yield adequate return to cover the cost of a multi-storey garage.

The system of public transport is also of great importance in this connection. In a city where the public means of transport are well developed, fewer persons will travel to the city's central areas in individual vehicles and consequently the demand for parking areas will be less. This will apply to the future Karachi also. If the network of local railways is developed to the extent suggested in the Master Plan, the system of parking here outlined would suffice for a long time to come.

If, on the contrary, the local railway system should not be further developed, the steadily increasing stream of motor-cars, resulting from rising standards of living, would cause intolerable parking conditions in the central areas. This is the present position in many American metropolises and has caused enterprises established in the centre to start branch offices in the outer areas, as mentioned on page 95, Chapter V. A similar development in Karachi could be attained through an expansion of the District Centres at the expense of the inner city.

Public Transport

Public transport in a city can be effected by buses, street tramways and local railways. The term local railways means a method of rapid transport which is made independent of other traffic by providing a special right of way and by grade separation at all intersections with streets and thoroughfares. A local railway system may be constructed at street level, or as an underground or elevated railway.

Among these means of transport, buses have the lower investment cost, but the operating costs are high due to the fact that the vehicles require considerable maintenance and have a short length

of service. The cost of power, on the other hand, is usually only a small percentage of the total costs. The cost of labour will be especially high, since comparatively small buses without trailers will have to be used, so that they can combine easily with other types of vehicles.

The cost of investment for street tramways is higher, but usually the cost of interest and amortization of the capital invested is quite small as compared with the operating costs. The latter can be kept lower than those for bus transit for two reasons: firstly, maintenance for trams is ordinarily less expensive than for buses, and, secondly, larger vehicles can be used on rails, so that the cost for drivers and conductors will be comparatively lower.

Street tramway transport is not practical in cities with narrow and closely spaced streets, since under these conditions the trams operate at low average speeds and also impede other traffic. They have therefore been replaced by buses in many cities, particularly in England. It should be noted, however, that in very large cities without tramways, the major part of the traffic load is taken by local railways and not by buses.

In many cities with spacious street systems, both in Europe and in America, the street tramways have nevertheless been retained and developed, and modernized cars have been introduced. As the tramway lines have been extended to new districts, the standard has usually been improved; the lines have their own roadbeds, separating them from other traffic, level crossings have not been permitted between stations, and all intersecting streets have been underpassed or overpassed. Thus, a fast transit system has been developed in which the central part is constructed as an ordinary tramway line with tracks in the roadway, while the outlying sections have a construction not unlike that of a local railway system, but with rails suitable for tram-cars. The average speeds in the outlying divisions can be kept high, thus reducing the number of cars and personnel required. It is not possible to use long trains, however, as this would not suit the traffic conditions in the central part of the system.

If a local railway system must be constructed as an underground railway, the capital investment will be very high. Elevated railways are cheaper to construct, though also fairly expensive. On the other hand, if the railway can be built mainly at street level, the preliminary cost of the structure will be moderate but will in any case be higher than that of an ordinary tramway system, due to the cost of grade separation, stations and signal apparatus. The operating costs will be comparatively low, because local railway systems operate at high speeds and with long trains.

Local railway systems originate in three ways. A street tramway system may be so developed that the outlying sections resemble a local railway line, and, at a later stage, the tracks laid in the roadways of the central city can be replaced by tunnels or overhead structures. Another alternative is that the suburban traffic carried on the main-line railways may be extended and intensified until it becomes an increasingly important factor in the traffic of the city itself, provided, however, that the main railway lines have four or more tracks, so that the suburban and city traffic have two tracks to themselves. Finally, local railways may be constructed to a unified plan from the start.

As a rule, local railway systems of the two latter types exist side by side. In this connection it should be noted, however, that the passenger traffic carried by the suburban and city lines of the main railways is usually not included in available statistics for urban traffic, although it may be of great importance.

The fundamental advantage of a local railway, as compared with bus or street tramway traffic, is its higher speed. In large cities it is necessary to reduce travelling time, not only for the sake of the passengers, but also for its very important effect on traffic economy. In London, Paris and Berlin, for example, the local railways were already under development before motor traffic existed. It

was only later that local railway lines were constructed to dispense with railway traffic at street level and to obtain more space for other vehicles.

The Traffic Systems in Five Metropolises

The traffic systems of four European and one American metropolis are briefly described below, as they are of interest in connection with this Report.

In London the traffic load is taken partly by the Underground system and partly as suburban traffic on several railway lines, among which the Southern Railway system is nearly as extensive as the Underground. The Underground consists of the Metropolitan District Lines, which developed out of suburban traffic on railway lines brought in through the centre of the metropolis in tunnels, and of the Tube Lines, which were first built as a very deep underground system and later extended at surface level through the outlying districts of London. These lines stretch far out into the suburbs from the heart of the city. As a rule, the lines are branched and converge at several junctions where trains are switched over from one line to another. In addition, there are trains covering only part of the lines. The system is therefore very flexible. Short-distance traffic is catered for mainly by buses.

In Paris the local railway system, the "Metro", now comprises 15 lines. These lines are restricted mainly to the comparatively small administrative area of the city, but have been recently extended into some of the suburbs. The trains usually run from one terminus to the other, and as many changes as desired between different lines can be made for the same unit fare. Within Paris the Metro system is so concentrated that the walking distance to a station is seldom more than a quarter of a mile. Therefore, travelling by underground is practically never combined with a bus ride to or from the Metro stations. On the other hand, there is in Paris an extensive net of bus lines serving mainly local short-distance traffic but also, to a certain extent, passengers travelling fairly long distances. The suburban traffic is carried mainly by the main-line railways.

In Berlin there are two local railway systems:—the municipal U-bahn and the state-owned S-bahn. The U-bahn runs mainly underground through the older section of the city, but certain stretches are on overhead structures or in open cuts. The S-bahn system developed from the suburban railway system, and extends far out from the centre of the city. One overhead branch of the S-bahn crosses the centre from east to west, and one underground branch from north to south, so that the S-bahn also plays an important part in the communications within the city. The U-bahn lines usually run two and two, and thus represent a mixture of the Paris and London systems. The S-bahn, on the other hand, has many branches. Before World War II, it comprised no less than 9 lines, each running on 10-minute schedules synchronized with one another, and with up to 5 lines on one section of the tracks.

In Moscow the "Metro" consists of three radial underground lines running through the centre of the city and a ring line about 2 miles in diameter encircling the centre. Additional radial lines as well as a new ring line are planned.

In Los Angeles the local railway system has been planned for ten main branches connected to a ring line, 1 to 2 miles in diameter, encircling the central area.

All the figures given for the traffic systems in London, Paris, Berlin, Los Angeles, as well as the system proposed below for Karachi, are drawn to the same scale for comparison.

Proposed Traffic System for Karachi

Distances will be very great in the Karachi of the future, and the city will therefore need a local railway system. The average speed on this system will be higher than on bus routes, since

buses are subject to the influence of other traffic even if they drive on express roads. With the traffic load to be expected here, the operating cost will be much lower for a local railway system than for other forms of transport. Since it is intended to build practically a new city at Karachi, it will be possible to run most of the local railway lines at street level, which will make the cost of construction much lower than that for the existing systems in Europe and America.

Thus the conditions are favourable for an efficient and economical local railway system in Karachi. In order to make its operation as efficient as possible, it should be the backbone of the traffic system and should carry the greater part of the passenger load. It is proposed, however, to supplement the local railways by some local train service on the main-line railways and by two or three through bus routes to districts too small to be served by their own local railway lines, as well as by a local bus system in the centre of the city.

The Local Railway System

The outer areas of the city are planned as Neighbourhood Units with local railway stations at their centres. These units with their stations will be distributed along the local railway lines. Each route will serve a district having 200,000 to 300,000 residents. Eight such districts will be served by the system, and will be connected in twos, thus resulting in four lines, all of which will traverse the centre of the city. In addition, it is proposed to build a local railway line, parallel to the railway circling the outer areas of the city, in order to provide direct connections for seven of the eight districts, without the necessity of travelling through the centre of the city. The lines traversing the centre will run two and two, and most central parts of the system will be four tracks wide when the development is complete.

For a city of 3 millions, however, 5 local railway lines will not be enough, if they are to carry the greater part of the traffic (cf. Paris, with 3 million inhabitants and 15 lines). The limit of their capacity will be reached long before the average number of journeys per inhabitant has risen to the same figure as in the western metropolises. There should therefore be arrangements for building the suburban sections four tracks wide, so that 16 lines will radiate from the central area of the city, connected by 8 double tracks through this area.

Even before the capacity of the double-track lines has been reached, it would be advisable to provide about half the length of the suburban sections with four tracks, so that express trains can use the outer tracks and locals the inner ones. With this arrangement the local trains turn halfway between termini, while the express trains continue to the outer termini as locals. This calls for only two tracks on the outer sections of the lines, but the right of way should nevertheless be wide enough for the construction of four tracks to allow for possible expansion of the city beyond the size now planned for. The express system is valuable not only for reducing the travelling time over the very great distances in Karachi, but also, as was mentioned previously, for economic reasons. The express trains will not stop at stations along the inner part of the suburban sections of the lines except at important junctions. Thereby, the average speed of the express trains can be raised to between 35 and 45 m.p.h., instead of 20 to 25 m.p.h., as for the locals. This will reduce the number of cars and personnel required. There should also be a saving on the capital investment, since, with a local railway system of the type proposed, the investment in cars, after development is complete, will be much larger than that in track and right of way.

The lines could not be carried through the city as it now stands, because it is not advisable to disrupt the present system of streets. As the present structures are of comparatively low value it would be cheaper to raze them where necessary and to run the four tracks that will connect the eight suburban lines on an elevated structure through the centre of the city, instead of underground. Where double connecting lines are needed through the centre of the city, these might

main-line traffic. Certain trains may run to the Port to transport workers during the morning and afternoon rush hours. During the earlier stages of development passenger traffic on the outer circle may be catered for by local trains on the outer circle tracks of the main railway in abeyance of the construction of the peripheral local railway line.

Rapid Bus Lines

Where the local railway system is not extended, its function must be performed by bus lines. These lines will have to carry very heavy traffic, and they should be entirely separate from the local bus lines. They should run as nearly as possible parallel to the planned courses of the local railway lines, so that the passengers will not acquire travelling habits which will make it difficult for them to change later from bus to rail service. In the new districts of the city this will be no problem, because the thoroughfares and the routes of the local railway lines have been planned to coincide, partly in order to facilitate conversion.

The bus stops should be widely spaced, so that the journey will not take too long. The sites of the stops for the bus lines should coincide with the stations of the future local railways, so that the factors determining the structure of the business district and the location of commercial sites will not be altered when the local railway system is developed and the bus routes are discontinued.

The distinction between the suburban and the local bus lines should be stressed. This can be done partly by spacing the bus stops further apart on the suburban lines, but the distinction should also be emphasized by a different system of fares, so that passengers in the present city area will not occupy places in the through buses to the disadvantage of suburban passengers.

The extent of the through bus line system should vary at different stages of development. Even after the local railways have been constructed in the eight directions proposed, the through bus lines from the central area to Kaimari and Drigh Road should remain, because these districts will not have enough residents to balance the population of the districts served by the local railway system. Drigh Road should also be served by the main-line railway. In addition, there should be a through bus line inter-connecting the northern part of the Golimar district, the Capital area, and the centre of the Korangi district.

Local Bus Lines

The existing tramway system should be replaced in the near future by a transport system which does not cause congestion in the narrow streets. The local railway should be therefore supplemented by local bus lines in sections located in the business and commercial centres. The system of local bus lines illustrated in the figure on page 184 is intended merely to give a conception of the proper spacing between the lines, and should not be taken as a detailed guide to the streets on which the buses should run. This can only be decided after careful study at intervals, during the development of the city, of the types of buildings constructed and the actual traffic flow.

The number of local bus lines should be such that the buses may run at intervals of 3 to 6 minutes on each route. Their routes should cross the centre of the city in various directions, so that it will be possible to get from place to place in this section without, as a rule, transferring from one bus line to another. In the Capital and University districts, some special local bus lines will probably be needed. On the other hand, local bus lines should be used in the outer districts only in exceptional cases. If these districts were to be built in such a way that they must be served by bus lines running at right angles to the local railway lines, with transference of passengers from buses to trains, this would prove uneconomic and would mean poor service for the passengers.

Service Sheds for the Rolling Stock of Local Railways.

If the proposed system of local railways is to be utilized to the limits of its capacity, with a train running every 90 seconds on every track within the centre, 500 trains of 8 cars each or a total of 4,000 cars should run simultaneously. It is expected that only every second train will run to the terminus, while every other train will turn back at a station lying approximately half-way. It is not anticipated, however, that the peak traffic will last long enough to warrant trains, at peak hours, succeeding each other at 90 second intervals on the entire line, and the actual number of cars may therefore be somewhat smaller. When making ground reservations for service sheds one should, however, reckon with this figure, viz. 4,000 cars running. If conveyance to the workshops is included, 5,000 cars will be required.

The rolling stock should be housed in about twenty depots, four on every local railway route. Two further depots should lie in the outskirts of the central area, though as close to it as possible. Two depots should be located near the termini when the line is completed. By spacing the depots in this way the percentage of cars running empty in the morning and in the evening, and at the beginning and at the end of the rush hours, will be kept low.

In order to distribute the cars evenly so that they do not stand idle, the last-mentioned depots should be made somewhat larger than the others and should be capable of housing about 300 cars each, which would mean that they should cover an area of about 500 by 500 ft. If space for workshops, shunting tracks and sidings is included, the required space would have to be about 1,300 by 800 ft., or 25 acres. The land to be reserved for the peripheral car-depots would be smaller in proportion.

CHAPTER X

INTERURBAN TRAFFIC

By nature Karachi holds a unique position as the gateway to West Pakistan. This will mean much to the development of the city and great demands upon arrangements for the interurban traffic will have to be met.

Attention should first be given to the development of the Port, and the Master Plan provides for an almost tenfold extension of it. The question whether it is feasible to build a waterway from Karachi to the Indus Valley is raised.

A circular railway around the future city is proposed, to serve the industries in the different districts and for the purpose of goods supply to the residential areas. Land reservation is proposed for 6 tracks for the North-Western Railway.

Land reservations are also proposed for two express roads to Baluchistan, and for one to Sind and the interior of West Pakistan.

Air traffic is likely to develop further. The capacity of the civil airport is great and can be increased still more, especially by building a new parallel main runway. Nevertheless, it seems advisable to reserve land for a complementary civil airport. Such a reservation is indicated near the Hub River.

The exchange of goods and services and the provision of facilities for travelling are the objects of a communication system and are a primary condition for the proper functioning of the world today.

As the mercantile and administrative centre for a large region, Karachi must be prepared for important long-distance traffic in various directions. Goods traffic will probably predominate in volume, although passenger traffic will increase markedly. It is of importance that the future transport needs be carefully considered, since the costs of construction work connected with transport will constitute a large part of the total investment requirements for the future Karachi. In many major cities in Europe and America, airports, terminals and roads quickly became overloaded, and subsequent improvements and additions were very costly in districts where every square foot of space had already been taken up for other important purposes.

Function and Integration of Transport

On account of the relatively low transport costs of shipping over long distances, this means of transport is predominantly used in international trade in the case of low and medium value goods. On the other hand, the comparatively slow movement of goods by sea is a disadvantage which tends to prohibit the shipping of commodities of high value and also reduces the power to compete for passenger traffic.

It may be anticipated that Pakistan will first of all engage in an extensive trade with countries that can be reached advantageously by sea. Since the topography is not favourable for competitive road transport, the main share of the foreign trade of West Pakistan is expected to pass through the Port of Karachi. In Chapter III the total volume of the trade anticipated to pass through the Port has been estimated to reach a magnitude of about 25 million tons per annum in 50 years' time. This figure should

not, however, be taken too literally, and when the figure 25 million tons is mentioned in the following, it should be interpreted as indicating a volume of, say, between 15 and 35 million tons.

As a general rule, ports are in themselves well adapted to receive large quantities of goods, but difficulties may appear when the goods are to be forwarded up-country. There is reason to believe that this may be the case to a high degree in Karachi, since a large proportion of the goods traffic may be concentrated to the communication line to the north-east towards the Indus Valley. This makes it extremely desirable that rail and highway communications to the north be supplemented by an inland waterway for long-distance transport of cheaper commodities. On inland waterways, however, some of the advantages of water transport are certainly reduced, since passage through canals and locks limits carrying capacity. If, in addition, extensive construction works are necessary, the resultant costs will be high. Railway and motor transport may therefore compete here on a more equal basis. In spite of this, inland waterways are still of great importance in Europe and in the U. S. A., where most large rivers have been made navigable and have been interconnected by canals. In the U. S. S. R., also, the canal system has been very much extended in recent years.

The Indus and its tributaries apparently offer possibilities for a similar system. As the Indus in its present stage is navigable to a limited degree only, it would be difficult to transport large quantities of goods in regular traffic without considerable work being carried out, including dredging, the building of canals, locks and lighthouses, the marking of navigable channels, etc.

If the building of canals does not appear profitable under present conditions, it may be accomplished at a future date, provided that foreign trade, and the demand for coal in particular, actually develops to the extent herein assumed. The more the volume of traffic expands, the greater the profit from initial investments.

Where the transport of large quantities of goods from Karachi to the Punjab is not undertaken by inland waterways, first consideration should be given to utilizing the railways for this transport. The cost of rail transport is greater than that of shipping but less than that of motor transport over long distances. Nevertheless, railways are at a disadvantage compared with motor vehicles, since they require to be well supported in order to offer desirable operating schedules at low costs.

Passenger traffic over shorter distances should be shared between train and bus. Since railways offer the advantage of great speed, they should, however, be used in preference on sections where they are already in existence. Buses have their special use within districts with too small a population to support railways, and for shorter distances of perhaps up to 20 to 25 miles where a more compact system and a closer timetable are desirable. Should districts around Karachi be built up, bus services to these areas will have considerable scope.

During the last few decades railways in America and in many European countries have met with strong competition from lorry transport. The latter has certain advantages, since road construction costs are borne by it to only a very small extent, and since lorries provide direct transport from door to door without unloading and reloading. Further, unlike railway traffic, they are not obliged to keep to a strict timetable, but can undertake transport at the exact time required by the client. Since, however, lorry transport requires reinforced roads in order to attain greater capacity and lower running costs, it should justly bear a considerable proportion of the road-building costs. Transport by motor appears to be strongly competitive only for the quite limited distances within which the lower railway transport costs are offset by the cost of reloading.

Motor-cars may also compete with the railways by offering better service under certain conditions.

The strongest competition for passenger traffic that the railways have to meet is from air transport. The aeroplane has become very attractive for passenger transport due to its superior speed and convenience, provided that distances are sufficiently long, and that the airport is so situated that the time for the journey to and from the airport does not exceed the time gained by flying. Today, at any given moment, there are more than 15,000 paying passengers in the air, and aviation appears to have still greater possibilities for development. Increased speed, greater safety and lower transport costs can be attained, and air transport can already in some instances compete with the rates charged by the Railways. Considering also the saving in time, the economic possibilities of air transport are even more obvious.

It may thus be presumed that passenger traffic between Pakistan and other countries, and primarily between East and West Pakistan, will come to be dominated more and more by the aeroplane. Most of the traffic will go via Karachi, as at present. But, since travelling time between Karachi and the Punjab, the North-West Frontier Province and the Quetta District is also considerably less by air than by train, requirements for air transport may arise even on those stretches already covered by the express train routes referred to above.

Valuable goods and perishables are also being transported by air over long distances, but the total weight of air-transported goods in all countries is very small in comparison with that of other means of haulage. In the U. S. A. air transport, including mail, covered only one three-thousandths of the goods carried by rail transport.

Karachi should thus become an important junction between many streams of traffic: international traffic bringing people and valuable goods by aeroplane, and goods of low or moderate value by boat, and national traffic carrying goods of low or medium value within the country by boat, railway and lorry, and people and valuable goods by railway, car and aeroplane. Large areas must be reserved for ports, airfields, railway stations, shunting yards, lorry and bus depots, canals, railway tracks and highways. The difficulty of forecasting far in advance the proper proportion between the ground requirements for different forms of traffic makes it necessary to set aside a greater total reserve in certain cases than the total traffic would reasonably require. Thus, the reserve for railways and stations should be made as if all traffic in the near future will go by this means, and, at the same time, a further reserve should be set aside for important canal and highway traffic.

Port of Karachi

Past and Present

Karachi's location is the result of the excellent, natural harbour site behind Manora Point—a unique formation on a coast which is otherwise inaccessible and unsheltered. The harbour has been in use at least as far back as 1725, but Karachi did not become a port, in the modern sense of the term, until its first pier was completed in 1854. Since that time the Port has been continually enlarged, and its traffic has grown at such a rate that before the Second World War about 2.2 million tons of cargo were handled there annually: about 1.3 million tons of outgoing and 0.9 million tons of incoming cargo. The traffic for the financial year 1944-1945 amounted to 2.8 million tons.

Functions of the Port

As mentioned above, the Port of Karachi will have to handle the shipping between West Pakistan and the rest of the world, including East Pakistan, except for those small quantities of goods which can be transported across the land frontiers. There will also be trans-shipment to and from Afghanistan and certain parts of the Indian Union. It is significant as an indication of the trend before partition that Karachi registered large increases in the receipt of goods from both the United Provinces

Detailed planning of the Port cannot be undertaken in a Report of this nature. Piers and wharves have been indicated in outline on the map in order to show that the area proposed for the Port corresponds reasonably well with the wharf requirements which have been calculated. If more wharf space is needed, an additional section of the free space will have to be used. The proposed barge channel to the Indus should run from Chinna Creek via a dredged canal to Ghizri Creek, and from there through comparatively sheltered waters along the coast. The barge canal must have locks, since the harbour is tidal.

Railways

Present Railway Transport

Karachi was connected by rail with the interior by the construction of the North-Western Railway in 1878. The main importance of the line is for the transport of goods between the Port of Karachi and the other districts of West Pakistan. Information obtained in January, 1949, indicates that the volume of transport, assuming full use was made of the waggons, should have been sufficient to move about 3 million tons of goods per annum. The total traffic through the Port in the financial year 1944-45 was 2.8 million tons. The daily goods transport amounted to 680 waggons, made up into 8 incoming and 8 outgoing trains. Through passengers were served by 8 trains, but the number of carriages may be estimated liberally at one-tenth of the number used for goods. There is also some local passenger traffic to Malir and Landhi, but not of significant extent.

Goods Transport in the Future

The total traffic to be handled in the docks of the future Karachi has been assumed to amount to about half of the total turnover, i.e. to 12 million tons per annum, provided that barge traffic can be organized on the Indus.

The main stations and the tracks to the north-east should be designed to handle an annual goods volume of from 15 to 20 million tons, so as to make ample provision for the estimated requirements.

If we estimate the average load carried by a goods train at 600 tons, and allow 20 per cent for empty waggons, the volume computed above will require about 60 incoming and 60 outgoing goods trains per weekday, or a total circulation of nearly 5,000 waggons per day. Such a volume of traffic will require a double-track line and a certain standardizing of the speed, say at 30 miles per hour.

It is impossible to predict the future distribution of the waggons among the stations in Karachi. The location of certain industrial plants might be an important factor in this problem. An attempt has been made to estimate, in terms of goods trains per working day, the amount of traffic that could be expected in the various Railway divisions in Karachi. This estimate indicates a future volume of internal traffic bordering on the maximum capacity of a single-track line, except for the Port, where the load will be considerably heavier. Since, however, the estimate might be on the low side, it would seem advisable to reserve land in the Plan for a double track to accommodate the internal goods traffic, preferably in the form of a circular line, so that there will be good connections throughout the city, although for a long time to come a single-track line will suffice.

Passenger Transport in the Future

The passenger traffic to and from an area depends not only upon the size of the population and the standard of living, but also, and to a greater extent than the goods traffic, upon the distance to, and the population of, the areas in which the other termini of the traffic are located. Naturally, the traffic on the railways will also be related to the volume of the traffic carried by other means of

transport. It is known, however, that passenger traffic in most countries bears an almost direct relation to the standard of living. If the railway continues in the future to carry the main load, then it may be assumed that the number of railway passengers arriving at or departing from Karachi will increase in step with the standard of living; that means it may be quintupled within 50 years, according to an estimate mentioned previously. If we also assume an increase in population of from one to 3 million, then we must expect that long-distance passenger traffic will be 15 times greater than at present. Information obtained indicates that long-distance traffic in July, 1949, amounted to about 2,600 passengers per day, including both incoming and outgoing traffic. Therefore it should be anticipated that there may be about 40,000 passengers per day in the year 2000. Since this traffic will mainly concern passengers travelling on journeys of 8 hours or more, it is advisable that the trains leave and arrive in the evenings and the mornings, respectively, so that they will be either day trains or night trains. It is better to cater for this long-distance traffic by means of a small number of comparatively long trains and, in addition, some express trains, than by a large number of short trains. On the Karachi-Hyderabad division, on the other hand, a rather tight schedule and somewhat shorter trains should be anticipated. Assuming 70 per cent use of the seating accommodation it may be estimated that there will be roughly 500 passengers per train on this division. If these assumptions prove correct, 80 through trains will be required—40 in each direction—when Karachi has a population of 3 million and when the standard of living is five times higher than at present. A traffic of this size will require a special double-track line. It will be advisable to bring all passenger traffic in to a central station in the immediate neighbourhood of the Central Commercial Area.

Proposed Disposition of Railway Lines

On the basis of the future volume of traffic estimated above, the railway system of Karachi has been planned as follows for goods and long-distance transport.

The North Western Railway, which is double-tracked, is expected to remain on its present route in Karachi but to be enlarged to one double-track for passenger transport and one double-track for goods. Right of way should also be reserved for an additional double-track, which may become necessary if the planned barge traffic cannot be realized, or if different speeds for different types of trains are required. It may also be utilized for possible traffic peaks, or for suburban traffic to new towns which may arise between Karachi and Hyderabad, or for other unforeseen requirements. Thus, land should be reserved for developing the North-Western Railway to a 6-track line as far as the City Station. In order to avoid the risk of a possible blocking of the whole track system as the result of a severe traffic accident or bomb damage, it is obvious that these 6 tracks should not run close together. Thus the land reservation required along the present main lines and/or for alternative new lines should be studied in detail. Between Malir and the Port there should be a circular route of two tracks forming a wide bow north of the so-called inner city, but inside the outer industrial and residential districts. Branches should radiate from this circular line to the industrial districts, with spurs running in to the factory sites. If necessary, the branches should be extended outwards to serve cultivated areas or land used for other purposes. As geographical conditions do not allow of such an extension to the north-east, a special reservation has been laid out for a railway in this direction. Should a railway to Baluchistan be required, it may use this right of way.

It is proposed that Karachi City Station should be developed as the main terminal for passenger traffic, and that the central goods terminal be developed in this location. Other goods stations should be located along the circular line and passenger stations provided along this line until the proposed suburban light railway line has been constructed.

One marshalling yard for incoming trains and one for outgoing trains will be required to handle the daily circulations of about 5,000 goods waggons. These yards, which could be

built as a unit, should be laid close to the main line near the junction with the proposed circular line, and should be extended as traffic increases, but sufficient land should be reserved from the outset to accommodate the yards. It is estimated that when the system is fully developed it will require 4 receiving sidings and 4 departure sidings for trains close to the marshalling yards, 20 sidings for preliminary sorting and 10 for final classification of incoming cars, and the same for the outgoing group. It is proposed to locate this main yard at Landhi.

In the port area, at Karachi City Station, and at the approaches to the various industrial districts, additional yards will be required for small-scale sorting. Sufficient land should be reserved to provide for 10 sidings in each of these yards serving the industrial districts.

Highway Traffic

It has already been mentioned that in recent decades lorry haulage has offered strong competition to the railways in many localities. Such haulage has, however, at least for the present, obvious limitations. In Western Europe the average length of haul for goods moved by lorry is 15 to 20 miles, while by rail it is 100 to 150 miles. Naturally, in other countries with great interior distances, such as the U. S. A. and U. S. S. R., both these figures are greater. With respect to Karachi, more than 90 per cent of the population of West Pakistan live at distances from the city considerably greater than those which are for the present regarded as economic for motor transport. It therefore appears that under present circumstances motor transit in Karachi will be purely internal. Should however the desert-like areas in the vicinity of Karachi and in southern Sind come under cultivation, this would certainly give rise to more extensive transport by lorry between Karachi and this hinterland. Such cultivation would also cause an increase in interurban bus and motor-car traffic. Motoring is rapidly developing and its possibilities for the future are as yet by no means determined. Therefore, it would certainly be wise to make right-of-way reservations for special highways intended to accommodate interurban lorries, motor-cars, and bus traffic in various directions from Karachi. Such highways, with extremely few crossings and high standards in other respects as well, should be brought in as far as possible towards the centre of the city. Long-distance traffic will require long-distance bus stations and lorry terminals. A bus terminal should first be established near the City Station. Lorry terminals might be located advantageously in the area at Chinna Creek, which is planned for storage depots, or in another central locality near the long-distance traffic arteries.

The Master Plan has a right of way reserved for two express roads for long-distance traffic to Baluchistan, and for one to Sind and the interior of West Pakistan.

Air Traffic

Karachi is one of the most important junctions for international air communications in the East. If the necessary technical facilities are provided to take care of a growing international traffic, there should be no reason to anticipate a change in this situation. With the general development of air communications, the traffic to Karachi should increase steadily. The internal traffic between the capital and other parts of Pakistan can also be expected to expand considerably, especially owing to the great distances between Karachi and the more densely populated parts of the country. The international and the national traffic is served mainly by regular lines and creates a heavy load for the air terminal.

Another category of traffic which tends to develop is the chartered planes and the private planes of similar character, used by industrial firms, the press and other businesses, for passenger and goods transport. An increased use of private planes for pleasure is also to be anticipated. This latter category of traffic does not require such extensive facilities as the regular traffic, but it is

desirable that the landing fields be provided with better connections with the heart of the city, so that the travelling time to the field will not be out of proportion to the length of the flights.

Seaplanes can be used to some extent for the chartered flights and for business and pleasure flying of a private character. The lower cost of base facilities for seaplanes is especially welcome for irregular traffic.

Certain circumstances also indicate that seaplanes may be used for heavier traffic as well. The larger seaplanes appear to be highly efficient and the low cost of base facilities, mentioned above, is an important factor.

Distance between Airports and Landing Fields

When zoning airports and landing fields, it is important, for reasons of safety, not to locate two ports or fields so close to each other that planes flying over them at the same time run the risk of colliding.

The space required over an airport or a landing field depends on the air traffic pattern, which should be carefully analysed for each individual case. In general, it would seem advisable to have at least 8 miles between airports, 6 miles between an airport and a landing field, and 4 miles between two landing fields.¹

Airports

To handle the regular air traffic, the Greater Karachi Plan contemplates first of all a development of the existing civil airport.

According to American standards, a single runway will allow a maximum of 40 plane movements per hour, which means that 20 planes can take-off and 20 planes land during one hour. It therefore appears that one runway for take-offs and landings at Karachi can suffice over a long period. It appears also that local wind conditions do not require a take-off runway to cover more than one direction.

It is assumed that the future airport will be classified by the code letter "A", International Express, which, according to the standards suggested by the International Civil Aviation Organization (I. C. A. O.), means that the instrument runway should have a basic length of not less than 8,400 ft., plus corrections. As the mean temperature for the hottest month in Karachi is 91°F, this adds another 1,300 ft. to the length as atmospheric correction, giving an ultimate length of 9,700 ft.² No corrections need be made for airport elevation or runway gradient, since the airport is located fairly close to sea level on flat ground. The width should be 200 ft. This runway is the metalled part of a landing strip with an ultimate minimum size of 10,100 ft. by 1,000 ft., which practically corresponds to what is now planned for Karachi.

Should a future expansion be necessary, it will be possible to place another runway of the same size parallel to the instrument runway. Before this expansion is required, the existing old runway may be used simultaneously with the instrument runway.

At each end of the landing strip there is an approach area where buildings are to be restricted in height. For instrument runways where the code letter is A, no buildings in this area should be erected above the horizontal, conical and inclined surfaces defined in the figure opposite.

¹ FROESCH, C., and PROKOSCH, W. : "Airport Planning", N. Y., 1946.

² 0.5 per cent for each degree in excess of the standard temperature of 59° F, as described in the "Technical Standard Order" Department of Commerce, Washington, U. S. A., November 4, 1947.

As regards Karachi, there do not appear to be any obstacles in connection with civil defence in the case of the airport, as the only settlement within some 3,000 ft. is military.

As a general rule, residential areas should not be developed within 3,000 ft. of the runways, because of the regular noise caused by planes on the ground. The noise caused by aircraft when taking off might also render large sectors surrounding the airport unfit or less suitable for residential purposes, especially as it seems likely that, in the near future, civil as well as military aircraft will have jet engines. When planes take off to the north-east, this does not appear to matter very much, since this area is not used for residential development, but when the take-off is to the south-west, which is ordinarily the case, large areas already planned for residential use will be affected.

On one of the plans placed as a frontispiece to this chapter approximate limits are shown, in connection with the future large airports, indicating where noise disturbances from jet planes taking-off would make the area unfit for residential development. The limits indicate a noise level of 65 decibels.¹ There is as yet insufficient research material available on noise problems concerning airports to provide clear guidance in planning, but it is evident that this question must be given special attention.

The noise caused by the aeroplanes might necessitate a limitation of the use of the present airport. As it would also be preferable, when the traffic volume has reached a certain limit, to build a new airport rather than to expand an existing one with new runways, the possibility of constructing an auxiliary airport in the future should be investigated. The area at the Hub River connected with the road to Baluchistan appears to be suitable in its fundamentals. Good connections to the centre of Karachi can be provided, and the distance across the mountains to the south offers satisfactory isolation of the city. There is also sufficient distance between this site and the present airport for air safety.

A seaplane base, not in use at present, is located at Korangi Creek. If seaplanes come into greater use in air traffic, this base may acquire importance, though it is perhaps too near the Karachi Airport for air safety. When traffic becomes heavy at this base and at the airport, traffic control at the two ports would need to be synchronized. Should the Karachi Airport be supplemented by a new large airport, as discussed above, this disadvantage would naturally be reduced.

Airports for Chartered Planes and for Business and Pleasure Flights

The irregular traffic should be served by a number of small airports connected with the various areas of the city.

These airports, according to I. C. A. O. standards, should have runways of the following sizes, including temperature correction (this does not apply to instrument runways):—

	I.C.A.O. Designation	Length	Width
Chartered traffic in general	F	3,500'	100'
Chartered traffic with small planes and private planes	G	2,500'	100'

¹ The limits are made up in accordance with an investigation carried out in 1947 by Vattenbyggnadsbyrån (VBB) in collaboration with the Swedish Public Health Institute.

standard of living—and subsequently the amount of travel between the suburbs and the centre—will rise in the future, the question of moving this airfield out of Karachi and using the site for building purposes should be considered. An investigation has shown that, with the assumed population of 280,000 in the residential area proposed, and with 60 per cent of the normal travel frequency of the Stockholm suburbs, the annual costs of the traffic would be reduced by about 50 lakhs of rupees by shortening the distance between the residential areas by 3 miles. Even if this travel frequency should not be reached in Karachi, the savings in reduced traffic costs would be very large.

Post, Telegraph, Telephone, Wireless

The General Post Office near the centre and the post office near the railway station should remain in their present location, but a site should also be prepared for a large post and telegraph office in the Capital. It would be advisable to move to this site the administrative departments for postal, telegraphic, telephone and wireless communications. There should further be a local postal and telegraph office in each Neighbourhood Centre.

A telephone exchange should be located in every District Centre and a major telephone exchange, to serve the Capital, located in the vicinity of the Jail.

The Telecommunications Training Centre could probably be developed in conjunction with one of the Government Technical Schools that may be established.

In accordance with the wishes of Radio Pakistan, and of the Army and the Navy, a large area has been demarcated south-west of Landhi for wireless transmitters.

Land should be reserved within the Central and Administrative Commercial Area for the central broadcasting operations of Radio Pakistan.

CHAPTER XI

PUBLIC SERVICES

The present water supply of Karachi, like that of many Eastern cities, is insufficient. It has a capacity of only 11 to 15 million gallons per day, whereas the water demand for the city in the first stage of development is estimated to be 70 million gallons per day, increasing to 270 million gallons per day in the future. The possibilities of obtaining large quantities of ground water in the vicinity of the city seem to be rather limited, and the greater part of the water demand is assumed to be met by surface water from the Indus, about 60 miles east of the city. Before distribution, this water will have to be treated by coagulation, sedimentation, filtration and sterilization. The distribution system in the city should have a pressure high enough to draw water directly from the taps, even in the upper storeys of the houses. High-level reservoirs should be installed for peak consumptions and to obtain water for fire-fighting, etc.

Since the seashore, to a great extent, will be used for bathing and recreation purposes, sewage discharged into the sea must be treated and the outlets of the sewers located at suitable places.

When the city area is expanding, the present Sewage Farms will have to be abandoned and new sewage treatment plants installed. Primary treatment (sedimentation) will be sufficient for sewage discharged into the sea, but if it is discharged into the nullahs, which are dry during certain periods, or utilized for irrigation of orchards or vegetable patches, which, owing to the scarcity of water, is most desirable, it should also undergo secondary (biological) treatment. Storm water should be drained by separate storm sewers and diverted to the nullahs or to artificial canals. The rain water should partly be utilized for the irrigation of parks and playgrounds.

All refuse from households should be collected in special bins and the City Authorities should provide for the removal and disposal of the refuse by incineration, or by composting.

The demand for electric power in Karachi by 1965 is estimated at 65,000 kW and it is likely that the increase in the demand over a fairly long period thereafter will considerably exceed 8 per cent per annum.

Water Supply

Present Supply

The following description of the present water supply of Karachi is a condensed extract from "A Short Note on Water Supply of Karachi" by Mr. G. M. Khan, Special Engineer, Karachi Joint Water Board.

The sources of the water supply to Karachi are two. One is the artificial lake at Haleji, at a distance of 55 miles from Karachi; the other is the Dumlotte Wells in the Malir Valley. The lake at Haleji is fed indirectly from the River Indus, through the Inundation Canals, when the river rises and remains high during the period from June to September. The storage of the lake is about 2,000 million c. ft., covering an area of about 5-1/2 sq. miles. It can supply from 7 to 8 million gallons per day for about ten months in the year. During the rainy season, which is of two months' duration, the natural supply of the lake balances the required draw-off. At other times the water supply of the lake depends entirely on whether the Indus rises to the required level; otherwise diversion of irrigation water from the canals is necessary. This may be inevitable in dry years, when the supply from the river may dwindle down to 6 million gallons per day.

Water is pumped from the Malir River basin by means of a series of artificial wells. If the rainfall is high, then as much as some 8 million gallons per day can be drawn from this source. The average supply may, however, be taken at about 7 million gallons per day, whereas in dry years the supply may be as low as 5 million gallons per day. If the hot weather is more severe, there is a possibility of the supply being reduced even further. It will thus be seen that the minimum and maximum yield from the present two sources comes to 11 and 15 million gallons per day, respectively.

The raw water from the lake at Haleji is led through a conduit to a pumping station at Gharo, from which it is pumped through a rising main to a purification plant for coagulation, sedimentation, filtration and chlorination. The treated water is led through another conduit to a pumping station at Drigh Road. From there it is pumped into a low-level reservoir for further chlorination and distribution to the city.

The water drawn from the Malir Basin is pumped from the wells and led through two conduits to the above-mentioned low-level reservoir, where it is mixed with the water from the Haleji basin. After chlorination the mixed water is distributed to the city.

The distribution of the water in the city is run by the Municipal Corporation, and the low-level reservoir, as well as four other reservoirs, are all under their control.

The present supply of water, as noted above, is between 11 and 15 million gallons per day. For the present population of about 1 million, the supply is equivalent to 10 to 13 gallons per head per day, including industrial and public consumption. This is quite inadequate for a modern city. As the present sources of supply are mostly dependent on sufficient rainfall and a corresponding rise in the Indus, both factors being not quite certain, a better and more reliable source will have to be obtained in the immediate future.

To meet this demand a project costing 4.2 crores has been prepared by the Water Board of Karachi. According to this project, "a 20-million-gallon scheme", the water will be pumped from the Indus and, after purification, delivered to the city.

It is assumed in the project that the present pumping stations and purification plant will be extended, a new main laid and, in addition, a high-level reservoir constructed in the city. It is proposed that this reservoir should have a capacity of 20 million gallons and that its high water level should be at R. L. 150 ft.

This project has not yet been carried out owing to difficulties in obtaining materials, etc.

Future Requirements

The quantity of water consumed in a city depends on the size of its population and on the consumption per head per day.

At present, Karachi has a population of about 1 million. Its future population has been estimated at about 3 million. The present calculations are based on the assumption that the future waterworks will, in the first stage, be able to supply water for a population of 1.25 million, and that the plant will later on be extended to provide water for 2 million and, finally, for 3 million people or more, if necessary. In this Report these three stages of development are called I, II and III.

The water consumption per head not only covers domestic consumption, but also industrial and public consumption and losses due to leakage. At present, the quantity of water per head consumed in a city is tending to rise, owing, on the one hand, to the more widespread installation of modern

sanitary conveniences, such as water closets, bathrooms, etc., and, on the other hand, to the industrial development.

In order to estimate the quantity of water required for Karachi in the future, the following comparative data are given for the average water consumption per head per day in some representative cities of the East and the Middle East (in 1947):

City	Total population in thousands	Population supplied per cent	Consumption in gallons per head of population supplied
Calcutta	2,109	60	118 ¹
Bombay	1,489	78	93
Cawnpore	780	31	42
New Delhi	522	13	30
Alexandria	750	93	56
Baghdad	550	36	66
Jerusalem	170	94	16
Beirut	240	96	37
Damascus	291	34	27

The above figures refer to the average consumption. The maximum consumption should reach an additional 50%. Rough calculations for the average consumption of the 9 cities given above indicate that 54 gallons are consumed per head per day and that the average maximum consumption might amount to about 80 gallons per head per day. It should, however, be pointed out that the consumption per head increases with the population. The average consumption calculated above should therefore by no means be used as a basis for estimating Karachi's future water demand.

A technical committee, appointed by the Government of Pakistan, having investigated the consumption of water in a number of cities in different countries, recommends—on the basis of the data collected—that the immediate requirement of Greater Karachi should be estimated at a minimum of 75 gallons per head per day. We share the opinion of the committee that this quantity ought to be sufficient for the next few years, if regarded as the average yearly demand, especially in view of the fact that a great many years may pass before the entire population will be provided with modern housing accommodation. In drawing up plans for the future expansion of the waterworks it should, however, be borne in mind (in view of the experience obtained in regard to other cities) that the future water consumption per head per day may be expected to exceed appreciably the above-mentioned 75 gallons. Assuming a gradually increasing consumption per head per day, the present and future water demand of Greater Karachi is calculated in the following table:

Stage	I	II	III
Population, in millions	1.25	2.0	3.0
" supplied, per cent	70	80	90
" in millions	0.9	1.6	2.7
Daily consumption—			
average, gal. per head	75	90	100
maximum, " "	110	130	140
Total consumption—			
average, mill. gal. per day	70	145	270
maximum, " "	100	210	380

¹ Including approximately 53 gallons of unfiltered water.

About one-third of the water supplied is assumed to be consumed for domestic purposes, and one-third for industrial purposes. The remaining third is allocated for public use, such as sprinkling of streets and parks, flushing of sewers, fire-extinguishing, etc., as well as for leakages in the distribution system.

Sources

In order to meet Karachi's requirements for water the following three possibilities should be examined:

- (i) Utilization of new ground-water sources.
- (ii) Increased utilization of surface water from the Indus.
- (iii) Production of artificial ground water.

It would be very advantageous if more ground water could be obtained in future than at present. As a rule, the cost of obtaining ground water is lower than that of obtaining surface water, which has to be purified. Furthermore, ground water has a low temperature even in the summer and generally a better taste than surface water. From the point of view of defence a ground-water plant is less exposed to damage than a surface water plant.

It will probably be impossible to obtain enough ground water to meet the entire calculated requirement of the city, but even the addition of small quantities to the complementary surface water will be valuable for improving the quality of the water supplied. Extensive ground-water investigations, including boring and test pumping, should therefore be made in the vicinity of the city.

In this connection, however, the question should be investigated whether an intensified ground-water withdrawal might not have a damaging effect on the vegetation within the ground-water area, and, if so, whether the value of the ground water obtained would make up for the loss in vegetation.

The greater part of the future demand will in any case be met by the supply of surface water, and the only adequate source will be the Indus. As soon as the construction of the Lower Indus Barrage has been completed, it will be possible to draw water from the Indus, about 60 miles east of the city.

The proposed investigations of the ground water resources should also deal with the possibility of artificial ground-water replenishment. If a part of the surface water could be converted into ground water, the cost of purification might be reduced and, in addition, the advantages mentioned above might be gained.

Since the future consumption of water is estimated to be very high, it will probably be necessary, nevertheless, to meet most of the city's water demand by drawing water from the Indus. This alternative is therefore primarily dealt with in the following.

Directions for Regulating Water Supply

Since, in future, large quantities of water will be required, the river water should be led from the Indus mainly through an open conduit to the purification plant. The use of a closed conduit for such a large volume of water would entail great expense.

The purification plant should therefore be situated as near the city as possible, since water will not remain pure if led through an open conduit. It should be considered, when drawing up plans for the water-works, whether the successive extension of the purification plant might not suitably be

constructed in the vicinity of the city, for instance, where the present main follows the Malir River, east of the city confines. The present site at Gharo, about 35 miles east of the city, should then be abandoned, since its capacity is only 10 m.g.d., i.e. merely a fraction of the future requirements.

In connection with calculating the dimensions of the aqueduct from the Indus, the quantity of untreated water required for the irrigation of areas within the city should also be taken into account.

The purification plant should be adapted for coagulation, sedimentation, filtration and sterilization. In this connection it might be mentioned that, thanks to recent research in Sweden and elsewhere, sedimentation basins and filters may now be made so much more effective than was possible only a few years ago that their capacity may be doubled.

The main low-pressure conduit from the waterworks to the city should be constructed of reinforced concrete pipes and the high-pressure conduit of concrete pipes with a steel core or of cast-iron pipes. Concrete pipes will probably be less expensive for such large dimensions as will have to be used.

The pressure in the distribution system should be high enough to make it possible to draw water directly from the taps, even in the upper storeys of the houses. It is suggested that the central part of the city and the low-lying settlements east of the city should form one common pressure zone, while high pressure zones should be arranged for the high-lying built-up areas west and north of the city. The water for these zones should be pumped from the central zone.

High-level reservoirs should be installed for peak consumptions and in order to provide reserves for fire-fighting, etc., in case the power supply is cut off. These reservoirs should be located within, or in the vicinity of, the built-up areas. In the central zone at least two high-level reservoirs should be provided, and in each of the other zones two reservoirs, if possible. The total capacity of the reservoirs in every zone should be at least 20 per cent of the estimated daily consumption of water within the respective zone. The estimated total capacity of the reservoirs in the central zone will be about 25 million gallons at maximum future demand and for a population of about 900,000. For the other built-up areas, with an estimated future population of about 300,000 each, the corresponding figure will be about 8 million gallons. The low water level should be such that the entire distribution area can be supplied with water conducted by gravity. The reservoirs should be constructed with fixed or floating covers in order to prevent too high an evaporation.

The pipes of the distribution system within the city should be constructed chiefly of cast-iron; in certain cases, for instance for large main pipes without connections, concrete pipes with a steel plate core should be used. In the central zone the main pipes of the system should be laid according to the ring system, and the subsidiary pipes should, if possible, be looped in order to avoid dead-ends with stagnant water.

Sewerage

Present Installation

In general the built-up areas of the city are provided with sewers. These have been built solely for diverting waste water from houses. For disposal of this sewage, the city has been divided into a large number of small areas within which the sewage is conducted by gravity to an ejector pumping station. There is a total of 20 ejector stations, driven by compressed air supplied from two air-compressor stations. 17 of these 20 ejector stations pump the sewage to the principal pumping station, which is provided with 3 electrically-operated centrifugal pumps. From there, the sewage is pumped to Sewage Farm No. 1 in the north-west of the city on the north bank of the Layari River. The sewage from the

remaining 3 ejector stations is pumped to Sewage Farm No. 2 in the south-east of the city, by the Malir River. A Swedish sewage pumping station with electrically-driven centrifugal pumps is shown on page 222.

The present installations are not satisfactory. There are many leakages in the compressed air conduits, and pipes often burst because they are corroded and worn away. The same applies to the pressure pipes carrying the sewage from the pumping stations. Hygienically there is very little to be said for the present system of Sewage Farms. As the city grows larger and the system of pipes has to be expanded, Sewage Farm No. 1 will in any case have to be discontinued, since it will gradually be surrounded by built-up areas.

Sewerage Systems

Three different systems are commonly used for disposal of the sewage of a city: the separate system, the combined system and the duplicate system.

If the separate system is adopted, only sewage and industrial waste are diverted by underground pipes while storm water is drained by gutters and ditches or by storm sewers on the ground surface. The combined system diverts sewage, industrial waste and storm water by the same pipes. The duplicate system consists of two separate systems of pipes, one for sewage and industrial waste and one for storm water.

In a city the size of Karachi either the combined or the duplicate system would normally be applied, the choice between them depending on the topography of the ground. If the sewage is to be treated, the duplicate system is decidedly preferable, since it leads to a more efficient purification and requires a less expensive treatment plant. As will be shown in the following, sewage from Karachi must be treated, and therefore its sewers should be constructed according to the duplicate system, or, where conditions permit, e. g. in the outer areas, to the separate system.

Volume of Sewage

The quantity of sewage almost equals the volume of water supplied. To this should be added a certain volume of ground water, including that from drains around the houses, which penetrates into the sewers through leaking joints. It is impossible to calculate exactly the volume of ground water, which may dwindle to very insignificant quantities during the dry season while amounting to considerable quantities during the rainy season. Experience has shown that the maximum volume of ground water more or less equals the quantity of sewage. When estimating the dimensions of drains, pumping stations, etc., the volume of sewage to be provided for should therefore be assumed to be twice the quantity of industrial and domestic water supply.

Before industrial waste is allowed to be diverted into the municipal sewers, it should be ascertained that the waste discharged does not contain substances liable to damage the pipes or disturb the purification process. Should injurious matter be present, special steps must be taken to counteract any harmful effects.

Receiving Waters and Purification of Sewage

As mentioned above, the sewage from the city is at present discharged at two Sewage Farms. At least one of these—Sewage Farm No. 1—will have to be transferred to another site, since the site now occupied by the plant is particularly well suited for building houses, etc.

The sewage may be discharged either into the sea or into rivers, but it may also be used for the irrigation of land under cultivation. The seashore of Karachi is used to a large extent as a place of recreation and as a bathing beach, and, according to the Plan for the future expansion of the city, a still longer stretch of the beach will be required for recreation purposes. Therefore, if the sewage is to be discharged into the sea it must first be treated, but, providing the outlets of the sewers are located at suitable places, primary treatment (sedimentation) should be sufficient. During the major part of the year, the rivers or nullahs crossing the city are dry, and it would therefore hardly be possible to discharge the sewage into one of these without previously subjecting it also to secondary (biological) treatment.

Irrigation

If the sewage is to be used for irrigation purposes, great care must be taken in order to avoid such factors, undesirable from a hygienic point of view, as offensive smells, flies, and, primarily, the risk of infection. The risk would not be so great for the irrigation of fields and in this case primary treatment should be sufficient. If, however, sewage is to be used for the irrigation of orchards or vegetable patches, it must undergo secondary treatment also and, if possible, chlorination, in order to attain effective destruction of disease-carrying bacteria.

In view of the prevailing shortage of water in the district the irrigation of cultivated land with sewage would seem preferable to its discharge into the sea or rivers. Sewage possesses, in addition, a certain fertilizing value, but this is unfortunately reduced by the biological treatment of the sewage.

A rough estimate shows that irrigation with raw water from the Indus might be more expensive than the use of sewage, even if the latter is subjected to secondary treatment. But provision would still have to be made for the discharge of sewage into some receiving water, since irrigation is not continuous during all seasons of the year.

Directions for Sewage Disposal

The most rational solution of the sewage problem would be to concentrate the sewage to a few treatment plants and to use the treated water for irrigation of areas located in the neighbourhood of these plants. It should, however, be borne in mind that it must be possible to discharge the sewage water into a river, or into the sea, during certain periods when no irrigation takes place. It cannot be determined, without thorough investigations, how many treatment plants will be necessary, nor where they should be located. Much may be said in favour of concentrating the main part of the sewage to two treatment plants, one for the west of the city and one for the east. In such a case, they should be located as shown on the map placed as a frontispiece to this chapter, or at some other sites which, after detailed investigations, might prove more suitable.

According to this proposal the west treatment plant would thus be located west of and adjoining the future harbour. The sewage coming from almost all the present built-up areas, and which is now collected at the central pumping station, could then be pumped up to the main sewer. This sewer could be laid on the north bank of the Layari River and up to the west treatment plant. The main part of the sewage from three of the built-up areas planned to be constructed west and north-west of the city centre, and possibly also from one or two areas north and north-east of the city, could be conducted by gravity down to this main sewer. The sewage from one of the north-west areas, situated partly on a plain inclined towards the Hab River and having a population of about 100,000 people, would, however, have to be diverted to the north, to a treatment plant on the Hab River.

When working to full capacity, the west treatment plant is assumed to be able to serve roughly between 1.5 and 1.8 million people. If the sewage, which is expected to reach a future

volume of about 160 million gallons per day in dry weather, and perhaps twice this amount in rainy weather, is to be used for irrigation, the cultivated areas (orchards or vegetable patches) should preferably be located west of the treatment plant. In such a case, the sewage would have to undergo secondary treatment also. The sewage which, temporarily, might not be utilized for irrigation would have to be discharged into the sea.

Should it not be intended to use the sewage for irrigation, only primary treatment would need to be carried out before discharging it into the sea.

The sewage from the treatment plant should not be discharged near the bathing beach; it might preferably be discharged into the Layari River estuary where the harbour of the city is situated. In this large basin the water will always be polluted to some extent by the discharge from boats and industries, and the discharge of the sewage here would cause little inconvenience. Owing to the action of the tide, the water in the basin should be renewed satisfactorily.

The east treatment plant should preferably be located in the vicinity of Sewage Farm No. 2, and the sewage from the east and south-east parts of the city centre should be pumped up to it. Most of the sewage from two of the large built-up areas planned to be constructed north-east of the city could possibly be conducted by gravity to the treatment plant. The sewage from two other built-up areas east and south-east of the city centre should be pumped to the east treatment plant.

When working to full capacity, the east plant is expected to treat the sewage from 1.0 to 1.3 million people. If the sewage, which is expected to reach a future volume of 120 million gallons per day in dry weather, and perhaps twice this amount in rainy weather, is to be used for irrigation, the cultivated areas should preferably be located south of the Malir River and perhaps also between the railway and the river. In such a case, the treatment plant would be equipped for secondary treatment also. If no irrigation is anticipated, the treatment plant will be equipped for primary treatment only. The treated water will be discharged into the Malir River estuary.

From the point of view of irrigation it might prove suitable to construct an additional treatment plant, north of the city centre, to which the sewage could be conducted by gravity from two of the built-up areas planned to be constructed north and north-east of the city centre. The treated sewage should, in such a case, be used for irrigation of gardens and parks in the Capital area. When the sewage is not required for irrigation, it should be discharged into the Layari River.

When working to full capacity, the north plant would receive sewage from 0.6 million people, corresponding to a volume of 55 million gallons sewage per day in dry weather, and perhaps twice this amount in rainy weather.

Adequate areas for the above-mentioned three sites should be reserved to provide space for treatment plants of maximum capacity as outlined above. The maximum space required is calculated to be approximately 200 acres for the west plant, 150 acres for the east plant and 75 acres for the north plant.

Even if the main part of the sewage can be conducted by gravity to the treatment plants, some large pumping stations will be required, especially for the city centre and built-up areas in the east. Moreover, several local pumping stations may be necessary for smaller low-lying areas.

All the sewage pumping stations are to be provided with electrically-driven centrifugal pumps especially adapted for the pumping of sewage. The existing ejector stations in the city centre should be re-built and provided either with small, local, electrically-driven compressor aggregates or with centrifugal pumps.

The sewers should consist of concrete pipes. The pressure pipes to and from the pumping stations should be specially constructed of concrete, cast-iron, or asbestos cement.

Storm Water

The disposal of the sewage of Karachi, as already mentioned, should be planned according to the duplicate or to the separate system, i.e. the storm water should be diverted by separate storm sewers or, if the local conditions permit, by gutters, ditches or canals.

In the central part of the city storm sewers should be laid in all main streets and also in side streets except for very short ones. In the outer residential areas the storm water should usually be drained by gutters to the nearest main street.

In order to avoid too large dimensions of the sewers they should, if possible, be extended to the rivers and nullahs which cross the landscape outside the built-up areas, or to artificial canals.

The volume of storm run-off from a certain area depends chiefly on the intensity and duration of the rainfall but also on the character and form of the drainage area and the slope and nature of the ground. For the calculation of the dimension of pipes, ditches or canals for discharging storm water, the run-off from the respective areas may be estimated according to the following formula :

$$Q = c \cdot i \cdot A$$

in which

- Q = run-off, in cusecs,
- c = a coefficient representing the average proportion of the rainfall that will reach the sewers,
- i = intensity of rainfall, in cusecs per sq. mile, and
- A = drainage area, in sq. miles.

The run-off coefficient varies according to the nature of the ground and the character of the built-up area. The following table shows the average run-off coefficient under different conditions :—

Character of area	Run-off coeff.
Central city areas with wide roofs and paved streets ..	0.70 — 0.80
Densely built-up areas, in general	0.50 — 0.70
Sparsely built-up areas, in general	0.30 — 0.50
Garden suburbs	0.20 — 0.40
Paved, open squares	0.80 — 0.90
Parks and gardens	0.10 — 0.20
Cultivated land	0.05 — 0.15
Forest land	0.01 — 0.10

The intensity of the rainfall in Karachi is shown on the diagram opposite, based on recorded rainfall figures collected between 1937 and 1949. Where exceptionally heavy rainfalls have been observed, these have been indicated by a cross. When calculating the dimensions of sewers it is not possible in practice, owing to the cost, to use the highest recorded intensities. Therefore, in extreme cases, the capacity of the pipes might be exceeded and the streets be submerged for a short while. In the diagram adequate assumptions for the rainfall calculation have been indicated by a line. If the dimensions of the sewers are calculated in accordance with these assumptions, their capacity may be exceeded only once every third year, which appears permissible. Since the rainfall records on which the rainfall calculation has been based cover a period of 12 years only, it is possible that still heavier rainfalls

have at times occurred and will occur in the future, and the diagram ought therefore to be supplemented by further data from time to time.

When using the diagram it is necessary, in the first instance, to estimate the time required for the water to run from the upper border of the drainage area to the lower end and to apply the intensity shown on the diagram corresponding to that time. By applying an average value of the run-off coefficient (c) and the intensity of rainfall (i) obtained as mentioned above, applicable to a certain area (A), the run-off can then be calculated according to the above-mentioned formula $Q = c \cdot i \cdot A$.

For calculating the run-off from very long and narrow areas higher run-off values can sometimes be obtained, if only part of the drainage area is included. In such cases it is necessary to make special calculations.

As an example, an estimate will be made of the run-off from a Neighbourhood Unit. For the purpose of the estimate, it will be assumed that all parks, sports centres, playgrounds and other green areas will be irrigated by the first part of the rainfall. By such an arrangement a retardation in the run-off will be obtained and the total time taken for the water to drain from the area is estimated to be about 60 minutes, corresponding to a rainfall intensity of 900 cusecs per sq. mile. The total area of the unit is assumed to be 2 sq. miles and, taking into account the varying nature of the ground, an estimate of the run-off coefficient gives an average value of $i = 0.45$. When introduced in the above formula, these values give a maximum run-off from the whole unit of 810 cusecs. The calculation shows that the storm run-off from the total area will be high, and it is advisable to divide the unit into two or more separate drainage areas, arranged according to local conditions.

City Refuse Disposal

Garbage and other city refuse must be disposed of satisfactorily from a sanitary point of view. The refuse should be collected in the households in special bins and emptied regularly by the municipal waste disposal department or by firms authorized to carry out such work.

Refuse disposal can be effected by 3 methods: by special composts arranged according to the sanitary-fill or Bradford-system, by grinding and discharging into the sewers, and by incineration.

Refuse composting presupposes that areas suitable for filling are located in the vicinity of the built-up areas. The composts should be placed in narrow strips about 7 ft. high and carefully covered with earth immediately after placing, thus isolating the refuse and excluding air. As a consequence, bacteriological decomposition will take place and by this process the temperature of the compost will rise. In the course of 1 to 2 years all easily oxidizable organic matter will have broken down, and the material will be odourless and harmless from a bacteriological point of view. This method is simple and cheap, but, as mentioned above, suitable areas be available for the disposal of the material. Areas filled with refuse cannot be used for building purposes for some 20 years to come.

The new method of grinding refuse and discharging it into the sewer has been adopted in some American sewage treatment plants. Before being ground, the refuse is sorted out and hard material, such as tins, etc., is removed. The refuse is then ground in special mills, discharged into the sewer and injected into the digestion tanks to be digested there together with the sewage sludge. This method is simple, but, if it is applied, refuse from households must be separated so that the garbage is collected in one bin, and paper, etc. in another. Large quantities of paper must not be discharged into sewers, since this would disturb the decomposition in the sludge digestion tanks of the treatment plant. Since it is very difficult to ensure that such a separation is carried out in the household;

this method has considerable limitations and will probably not be applied in Karachi. In this connection the house grinding apparatus for disposal of kitchen garbage into the sewer should also be mentioned. Such machines (the "Disposal" and others) are now extensively used in the U. S. A., but it will probably be a long time before they will be used generally in other countries, since they are rather costly for the owners of houses.

From a sanitary aspect incineration of refuse is superior to all other methods. This method is commonly used for the disposal of refuse in large cities, particularly in the U. S. A. If combustion takes place at a temperature of at least 1800°F, all odour is avoided. The ashes are used as filling material and the heat can be utilized for generation of electricity, or for other purposes, which renders this method advantageous from an economic point of view.

From the above considerations it is apparent that the city refuse of Karachi would be most suitably disposed of by incineration, or by sanitary-fill.

Comprehensive investigations will be necessary in order to ascertain which of the two methods should be adopted, but this does not fall within the scope of this Report.

Power Supply

A large city, like the future Karachi, will need power for many purposes: for its industry, for railways, buses and motor-cars, for indoor and outdoor illumination, for electrical household equipment and other domestic purposes, for air-conditioning and refrigeration, etc.

In the "Report on Power Development Plan" submitted by MRV(P) in December, 1950, the demand for electric power in Karachi by 1965 is estimated at 65,000 kW. It is considered unlikely that the increase in demand, over a fairly long period, will exceed an average of 8 per cent per annum over the country as a whole. In Karachi, however, it is expected to exceed this figure considerably, mainly due to the increase in population. Therefore a large-scale transmission of hydro-electric power from the northern parts of West Pakistan may be anticipated. In addition, thermo-electric power generation will always be required for Karachi, and such power-generating stations should be located in the port area and in the industrial areas. Apart from the generation of electricity, large quantities of coal and oil will be needed to cover the city's other energy requirements.

CHAPTER XII

SPECIAL REQUIREMENTS

The daylight, even during the darkest months of the year, appears to make artificial illumination unnecessary during normal working hours, provided that the buildings are properly planned.

To avoid excessive solar radiation, the buildings should be located with their facades facing mainly north and south. To obtain the desired cross-ventilation, the buildings should preferably have their facades facing south-south-west and north-north-east. An orientation between those mentioned above would more or less satisfy these two requirements and is to be preferred.

Noise from various sources can be a serious hygienic problem. The first step to ease noise conditions should be to lessen the disturbance at its source, but proper arrangement of the built-up areas is also of importance. Belts of unbuilt land should be laid round traffic thoroughfares and noisy industrial installations. When new airports are built and the flight pattern decided, noise disturbance from the airport should be considered.

In the previous chapters various factors have been discussed which influence the planning of the city. This chapter will deal with some special requirements which also should be considered, particularly when preparing the detail plans.

Daylight

In the latitude of Karachi the daylight is almost constant throughout the year. The difference between summer and winter is small. In winter the days are 1.5 hours shorter than at the equinoxes and in summer 1.5 hours longer. In December, the darkest month of the year, the daylight—even from an overcast sky—appears to be sufficient to make artificial illumination unnecessary during normal working hours, provided that the lay-out of the buildings is properly planned with regard to this desideratum.

The need for daylight illumination of a satisfactory intensity should be taken into consideration in preparing the detail plans for houses and working premises. Special attention must also be given to this requirement when designing the central areas of the city. The quality of daylight illumination indoors is conditioned by the depth of the rooms, the window area, and similar factors, but it also depends on the screening or blocking caused by the surrounding buildings and vegetation. This latter effect should be considered when grouping the buildings.

The intensity of the daylight in a building, properly expressed as the *daylight factor*,¹ can be determined empirically for various angles of incidence, types of room and fenestration, and the like and thus the distribution of daylight in a building can be plotted. The value of this factor should be compared with a certain standard for daylight illumination such as that set after the investigations made in England at the Building Research Station in co-operation with the Ministry of Town and Country Planning :

“The standard recommended for offices, which the proposed code is designed to achieve, is a daylight factor of 1 per cent at a distance of 12 feet from the outer face window wall at a height of 2 feet 9 inches above the floor.”

¹ The ratio of the illumination at a specified point to that on a horizontal plane with an unobstructed horizon, i.e. a flat roof high above the surrounding building.

In Karachi, where the daylight is much more even throughout the year, this requirement could reasonably be reduced to 0.75 per cent, until a more detailed investigation has been made. In houses the objective should be to attain a daylight factor of 2.5 per cent at a distance of 5 feet from the outer face window wall at a height of 2 feet 9 inches above the floor and a minimum daylight factor of 0.25 in the interior of the room.

Solar Radiation

The requirement for a minimal screening effect, as a condition of good natural illumination, is counterbalanced by the need of large angles of incidence for limiting the solar radiation into the buildings.

Under the climatic conditions prevailing in Karachi, it is desirable to limit solar radiation into the buildings during most of the year in order to prevent an undesirable heating effect. It is only during the winter months of December and January that this solar radiation is welcome as a source of warmth in the buildings. In February, March, and November, the temperature is quite comfortable in general, but during the other months the sensible temperature is high. It is true that the conditions are modified from time to time by wind and clouds, but seldom as much as would be desirable.

The intensity of solar radiation upon facades oriented in different directions has been calculated month by month. The results of these calculations, illustrated on the opposite page, show that during the period from April to August the strongest radiation falls upon walls facing east or west, while during the other months it is strongest on walls facing south. In May, for example, the total radiation on the walls facing east and west is more than four times greater than that received by walls facing north and south. It is therefore advisable to orientate the facades of the buildings mainly north and south. Thus they will be exposed to as little radiation as possible during the hot months, while during the winter months a maximum radiation will be received.

Orientation with respect to Winds

A factor to be considered in addition to solar radiation, when planning the orientation of the buildings, is the winds. During the warm season it is especially important to have abundant air currents both indoors and between buildings. Stronger air currents reduce the sensible temperature. This object can be attained indoors to some extent with fans, but obviously the natural air currents, i.e. the winds, should be made use of both indoors and outdoors as much as possible. Since the winds blow nearly constantly from the south-west and west during the warm season, the buildings should be planned so as to favour the circulation of these winds through and among them.

Without special research on this subject, it is not possible to indicate in detail how the buildings should be designed to obtain the best natural ventilation. However, previous investigations can provide some general guidance.¹

If a single building is set at right angles to the direction of the wind, there will be an area of turbulence—the "wash"—in which the wind at ground level flows against the direction of the undisturbed air current, as shown in the lower figure on the page opposite. The length of the wash in the direction of the wind, when the velocity of the wind is constant (the small variations in wind velocity dealt with here do not affect the size of the wash), will vary in nearly direct proportion to the height of the building but will be influenced by the shape of the roof. The velocity of the wind in the turbulent area, however, should be independent of the height of the building. There will also be some turbulence at the ends of the building: its effects will be felt for about 100 ft. in from the ends.

¹ S. LUTHANDER and T. GULLSTRAND: "Undersökning rörande byggnaders lämbildande förmåga" (Investigation into the Capacity of Buildings to provide Shelter in their Lee), Stockholm, 1945.
Committee on the Hygiene of Housing, American Public Health Association, Housing for Health, Lancaster, 1941.

When a number of buildings are grouped in the same vicinity, as in an ordinary town, there naturally arise complicated air currents which it would be an extensive undertaking to plot in detail. It is important, however, not to locate buildings in one another's wash, as the air movement both between and through the buildings would then be slight. This is the case, for example, with buildings constructed in the form of an L or T, and with courts surrounded by buildings. If the buildings were laid out in rows parallel to each other and perpendicular to the wind direction, the spacing which would be necessary between them is too large to be acceptable from other stand-points, viz. planning economy, short walking distances, etc. On the other hand, a grouping of the buildings parallel to the wind direction is not desirable because, among other factors, the cross-ventilation of the houses in this case would be slight.

The wind is probably best exploited by orienting the buildings at an angle of from 45° to 60° with relation to the wind direction. The main effect here will be spiral air currents along the areas between buildings, which do not need to be more widely spaced than at the customary distances between different types of buildings. The velocity of these spiral air currents has also been found to exceed the velocity of those in the wash behind buildings oriented at right angles to the wind.

As stated above, the shape of the roof affects the air movements over a building—an especially important factor for single-storey buildings. The lower figure, opposite, shows the air currents formed by three types of roofs. The illustration makes it clear that the arched roof is preferable from this point of view, the air being drawn down behind the building and thus reducing the size of the wash.

Obviously, dense stands of trees hinder air movement. It would be best for the purpose of ventilation if trees in the residential areas were palms and other tall-trunked varieties which allow of good circulation below their crowns.

To make the best possible use of the wind for ventilation the buildings should be oriented at angles of from 45° to 60° with relation to the direction of the wind, i.e. south-south-west to north-north-east or west-north-west to east-south-east, as shown in the upper figure on page 232. The latter orientation cannot, however, be used on account of what has been mentioned above with reference to solar radiation. In order to increase the cross-ventilation low houses should be built with arched roofs. It must be emphasized, however, that the research work in this field is not yet complete. For verification of the results, it would be advisable to investigate the air currents in newly-constructed residential areas in Karachi.

Noise

Noise from aircraft, from traffic arteries, from industrial establishments, and from other sources, can be a serious hygienic problem. The health authorities in many countries receive a steady stream of complaints from persons disturbed by excessively loud noises from various sources. Naturally enough, the chief complainants are the shift workers who have to sleep during the day, but others complain as well. The most numerous complaints are against traffic of various kinds, but such noise sources as wireless receivers, street vendors, and milkmen are also the subjects of protest. An investigation made in New York in 1930 indicated the following division of complaints with reference to sources of noise:

Street traffic (excluding trams)	..	..	..	36%
Trams and suburban railways	..	..	..	16%
Loudspeakers in houses and in the street	..	..	..	12%
Street-cleaning, milk delivery, etc.	..	..	..	9%
Fire sirens, whistles of locomotives and ship sirens	..	..	..	8%
Street vendors, dogs, cats, noisy parties.	..	..	..	7%

In many countries public health officers have attempted to improve conditions in their communities by prescribing noise-abatement measures of various kinds, such as sound insulation in the buildings and certain specifications as to the design of buildings. Attention to the noise problem in the planning of urban construction may also contribute in many ways to noise abatement.

Measurement of the noise level is made in decibels: the decibel is a unit expressing on a logarithmic scale, how much stronger a sound is than the weakest sound that an average person can perceive under the most favourable conditions. However, our ears also discriminate between sounds of various frequencies: for instance, a sound with a frequency of 100 to 200 cycles per second is generally heard as less intense than a sound of higher frequency—say 1,000 cycles—of the same strength, as expressed in decibels. An attempt to allow for these physiological characteristics of the ear is made by using the unit called the phone. The relationship between decibels and phones, at different frequencies (cycles per second) is illustrated in the figure opposite.

The approximate intensities of various noise sources, expressed in phones, are given below:

Aeroplane engine at a distance of 20 ft.	120 phones
Compressed air drill at a distance of 10 ft.	100 "
Spinning room in cotton mill	90 "
Wireless in a living room	70 "
Noise in a quiet street	60 "
Conversation	50 "
Quiet flat or office	40 "
Very weak wind in forest	10 "
Limit of audibility for the individual	1 "
Pain level for the individual	120-130 "

Sound which spreads without obstruction decreases in strength by 20 decibels for each tenfold increase of the distance from its source. Reflection and absorption into the ground modifies this simple proportion, so that the propagation of sound varies with the character of the ground and with the presence and nature of the vegetation. Tentative Danish research¹ seems to show that an asphalt surface gives the best sound-damping effect for sounds of low frequency, such as the noise from a motor (a 23-decibel decrease with a tenfold increase in distance). Large trees and expanses of grass without trees or shrubbery have a somewhat poorer damping effect, and bushes alone seem to be poorest of all. For sounds of higher frequency, such as motor horns, however, the effect appears to be reversed; for such sounds the asphalt surface has the poorest damping effect (a 17-decibel decrease with a tenfold increase in distance), and bushes the best (21 to 22 decibels).

A British investigation² of noise intensity at various distances from traffic arteries and streets gives the following results:

	Loudness at building-line, in decibels		
	At curb	20-30 ft. back	150-200 ft. back
Arterial roads (high-speed, long-distance traffic by day and night)	100	95	80
Subarterial roads (urban traffic, connecting local traffic and arterial roads)	90	85	70
Local roads (shopping and residential; little through traffic. Quiet at night)	70	65	50
Local roads (residential only)	40	35	20

¹ VILH. LASSEN JORDAN: "Om Støjdaempning Ved Laebaelter" (Noise Abatement by means of Shelter Belts), Byplan, 1950, No. 8.

² The Codes of Practice Committee, Ministry of Works, "Interim Code of Functional Requirements for Dwellings and Schools" (draft for comment subject to revision), London, British Standards Institution, 1944.

If there is to be an improvement of these conditions, the first step should be to attack the disturbance at its source. Prohibition of unnecessary use of the motor horn by introducing "silent" traffic, mufflers on motors, proper construction of tracks for long-distance and light suburban railways, and mounting of extremely noisy machinery on insulating bases, can do much to reduce noise. In addition, the proper arrangement of the built-up areas gives excellent results. Thus, open belts should be laid out around traffic thoroughfares and noisy industrial installations. Construction should be limited around airfields, and especially near the take-off and approach areas. Under certain conditions, vegetation could probably also be employed to muffle noise.

In residential districts well separated from factories and thoroughfares, wireless receivers, barking dogs, and the like are usually the most irritating sources of noise. These disturbances can be reduced to some extent by grouping the buildings in such a manner that there are no narrow courts in which the sound is easily reflected from wall to wall. For the same reason, houses should not be so arranged that there are long parallel facades along narrow passages.

As stated above, public health officers in a number of countries have turned their attention to the noise problem. The League of Nations' Health Organization recommended in 1937 that measures be taken to prevent the noise level in living rooms from exceeding 50 decibels, and in study rooms and bedrooms 30 decibels. Considering that the noise level inside an open window is usually from 5 to 15 decibels lower than just outside the window, and that open windows are a necessity for air circulation in summer, it appears that exterior noise levels in the proximity of bedrooms should not exceed 40 to 50 decibels and that the noise level at any point in the immediate vicinity of a residential structure should not exceed 50 to 60 decibels.

In Sweden the authorities recommend that the noise intensity should not exceed 40 phones in living rooms and class-rooms with windows and doors closed. In hospital rooms, a maximum noise level of 25 phones is permitted. At the same time, however, insulation from air-propagated sound of 48 decibels in living rooms and hospital rooms and 44 decibels in class-rooms is required.

The noise caused by aircraft is dealt with in Chapter X in connection with airport planning.

CHAPTER XIII

STAGES OF DEVELOPMENT

The realization of the Master Plan is expected to take about half a century. In many respects it is a plan for land reservation so as to ensure a gradual, unhindered future development.

The recommendations given in the Plan should be applied in stages. For practical purposes, the first stage should cover an increase in population of up to 1.5 million people. In this stage the industrial development should be concentrated to the centre of the city and to the harbour area.

The Golimar District and its continuation to the north-east, those parts of the Capital south of the Layari River which are not reserved for public buildings, the Housing Societies' area at Drigh Road, Clifton and the districts north of Mauripur should, in the first stage, be developed as residential areas.

No large-scale development of the express road system will be necessary during the first stage, but the thoroughfares through the central parts of the city should be attended to at an early date.

The outlying districts should be developed one after the other, and when such a district is near completion a new one should be opened up. The new districts should be prepared for the reception of the population now living in poor circumstances as well as for the expected increase in the population of Karachi.

The Master Plan is a long-term plan; its realization is expected to take more or less half a century. It presupposes that a very quick, almost revolutionary, development of economic and cultural life and of the standard of living will take place in Karachi during this period. The suitability of the Plan depends not only on whether the future requirements have been correctly judged, but equally on whether sufficient consideration is taken of conditions which will prevail during the period of development. When the Plan is put into practice, many of the structures which will markedly influence the city's life in a later phase may be of little or no importance in the first stages. All the capital investments necessary for a complete development of public services cannot possibly be made for a long time. To achieve such development Karachi, and Pakistan as a whole, will have to become more industrialized and mechanized and acquire a considerably increased productive capacity. It is, of course, by no means implied that Karachi will become primarily an industrial city—only that modern methods should be applied in all respects.

It should, however, be emphasized that the completion of all structures included in the Plan will not be required until a higher standard of living has been attained; for example, the need for express highways will depend on the growth of motor traffic. During the first stages, and perhaps within the whole period planned for, these highways may function even with a lower standard than is outlined in this Report.

The Master Plan, as is clear from the drawing showing the final stage, is in many respects a plan for the land reservation that should be undertaken to ensure an unhindered future development. The Plan has been drawn up in such a way that the reservations proposed will interfere very little with the existing conditions and require the least possible capital investments in the early stage. If the Plan is adhered to, installations and buildings which will be put up at the outset need not be razed later and replaced by new ones. A gradual expansion to the future scale and capacity should thus be possible without undue difficulty.

The First Stage

An important function of the Master Plan is to indicate a first construction stage for which recommendations are given regarding the location of work and residential areas, lines of communication, etc. This first stage is easier to survey than the long period which the Plan in its entirety is intended to cover. If the detail plans are drawn up in stages, safer assumptions can be made as to the economic life and standard of living, on the one hand, and the technical development and capacity for investment, on the other.

The limits for the first stage ought not to be made too wide—whether expressed in population increase, in a demarcation on the map of a certain area around the present city, or in time. For practical purposes the first stage should cover an increase in population from the present 1.1 million, according to the 1951 census, up to 1.5 million.

The Economy Factor

In view of the present economic structure of Pakistan, and with due regard to its publicized economic policy, it may be assumed that the country's wealth will not primarily be invested in a development of industry in Karachi. There are more pressing tasks, such as the modernization of agriculture, the building-up of the textile industry with regard to the available raw materials, and the nurturing of the cottage industries in the overpopulated agricultural districts. Such a programme places great demands on import and export trade, and Karachi's significance as a harbour and commercial city may be expected to increase in step with the expanding economy in the West Pakistan hinterland. As the federal capital and cultural centre, Karachi's growth will correspond to the development of the country as a whole.

In this first stage of development there will be a heavy concentration of places of employment to the centre of the city and to the harbour area, and the need for purely industrial areas will be comparatively small. The number of workers within industrial areas is estimated to increase from 50,000 at this stage to about 150,000 in the final stage.

The Standard of Living

It should be assumed that the anticipated increase in the standard of living will not take place evenly during the whole period, but will begin modestly and accelerate gradually. Even if productivity increases rapidly, the necessity for investment, particularly in the beginning, will be so great that the increase in national income will not take the form of a higher standard of living to the same degree as at a later stage.

In the building programme this will be apparent in a comparatively low housing standard, a slower development of schools, hospitals and recreational facilities and in considerably less desire to participate in the various activities in the life of the city. There will be less demand on the internal traffic system, and the number of motor-cars, in particular, will probably be significantly lower in the first than in the final stage.

The Industrial and Commercial Areas

In the Master Plan the central business district is referred to as the "Central Administrative and Commercial Area" and the area for "Mixed Development". The western part of this area, centred around Bandar Road, is mainly built up; the eastern part leads into the still undeveloped Capital area. The question as to which part of the district should be used, in the first stage, for places of employment cannot be answered without such a detailed, far-reaching investigation as can hardly

be included in the Master Plan. The western section of this area may be expected to become more and more utilized for commercial activities, and their auxiliary service industries, through alteration of the existing dwellings, or by razing and replacing them with new shops, offices, warehouses and industrial buildings. The development of the new Capital will be entirely dependent on the decision of the federal authorities. In the beginning, only the most westerly section of the land in this area will be required, but an exact demarcation of the central district is not necessary in this connection.

The harbour, central railway and warehouse installations can continually be extended within the districts indicated in the Plan for such purposes, without appreciably affecting the manner in which the districts are being used at present, one reason being that development is largely intended to take place on reclaimed land. It should be recalled that a large part of the industrial development is presumed to take place later on in this stage within the harbour area.

In so far as new industries ought not to be brought into the central district and harbour area, they should be located mainly in the industrial areas which already have good communications, so that new investments in railways and roads can be avoided as far as possible. These industries should preferably not be situated so near the city centre that the dwellings located in that area will need to accommodate the industrial workers. At this stage of the development it is especially important that travelling distances to places of employment be reduced, and that the least expensive type of transport be used, e.g. bicycles, since the desire for convenient access to the centre, and other parts of the city, will not be so pronounced in the beginning. The realization of the concept of the Master Plan that, in this respect, the city shall function as a unified whole, is bound up with a higher economic, social and cultural level than Karachi is expected to attain within the near future.

The Trading Estate has the advantage of already developed communications, but its distance from the Central Commercial Area is less than is desirable with regard to the availability of suitable ground for housing accommodation. If the Trading Estate is constructed for 30,000 workers (according to the Plan the area can ultimately accommodate 35,000), the corresponding total population in the first stage of expansion can be estimated at approximately 120,000.

Malir and Landhi are denoted in the Master Plan as industrial areas which should be used in the first stage of development, since both are well situated from the point of view of transport, having good rail and road connections to Karachi proper in the west, and to the Indus valley in the east. Furthermore, these areas have the advantage of lying near the main water supply lines to the city, which may be of significance in the first stage. It should be recalled, however, that the industrial district of Landhi lies quite near the sea, and industries affected by salinity in the air should not be set up there. If two-thirds of the Malir district is utilized during the first stage, as well as an equally large part of Landhi, easily accessible from Landhi Railway Station, 20,000 workers can be reckoned as working in the satellite town formed by these two districts during this stage. The corresponding total population is estimated at 80,000.

An important part of light industry will be located in the residential districts. Other industrial enterprises, such as quarries confined to certain places outside densely settled areas, will always employ some thousands of workers. There will also be a considerable number of workers, especially in the building and construction trades, who will have no fixed places of employment. If this is taken into consideration, it appears probable that industrial areas other than the three above mentioned need not be taken into consideration in the first stage.

Residential Districts

At present the population of Karachi is heavily concentrated in the centre of the city. Sub-urban settlements are almost entirely lacking, except in Malir and in certain defence areas. Without

access to detailed population statistics it is estimated that the number of people living within the city proper south of Layari and west of the Jail, including temporary refugee camps, is about 1 million. As is well known housing conditions for the great majority are most unsatisfactory. The permanent houses are generally over-crowded, and a considerable part of the population lives in temporary dwellings consisting of tents and huts without sanitary conveniences. It need hardly be said that the present state of affairs cannot remain unchanged for any length of time, bearing in mind the danger of devastating epidemics, as well as the inhabitants' right to at least a minimum level of existence.

The Master Plan anticipates that a considerable movement away from the central city area will take place before the final stage is reached, leaving the population at, say, 600,000, i.e. at two-thirds of the present number. If it is taken into account that economic life will be strongly developed in this area during the same period, that street widening and cutting of new streets will be undertaken, and other traffic facilities made available, and that parks, schools, hospitals and other public services will be introduced, this reduction in the population of the present city hardly implies any lowering of the average density in the remaining residential districts. Social and sanitary improvements must be achieved through equalization of the population density in the city sections, as well as by slum clearance. In general, clearance can only be brought about by increasing the height of buildings and by replacing districts now covered with huts by high blocks of flats. The area that comes first to mind in this context consists of the Layari Quarters and adjacent districts, but the same applies, of course, to many other existing areas with a "kutcha" settlement of poor buildings. The realization of such a programme, however, would have to extend over a long period, and could probably not be accomplished entirely within the first stage of development. Two reasons for this are that the cost of erection of multi-storeyed blocks of flats is much higher than that of low buildings and that, for the present, such flats would not be suitable for housing the people now living under bad conditions. In the near future a reduction of the population in the built-up area is to be expected mainly by partial depopulation of the poorest quarters, without changing the provisional character of existing buildings. This can be done only by construction of new residential districts for the families removed. It is important, however, that, as soon as possible, the available resources should also be allocated to the building of large blocks of flats, in order to implement a long-term policy of slum clearance. Otherwise, it must be feared that no real improvement of such areas as the Layari slums will be possible within a reasonable length of time. The initiative of the Government may be needed to ensure that this programme is carried out. No scattered groups of low-storeyed permanent houses should be permitted in the central district, either in those parts that are to be cleared, like the Layari Quarters, or in such residential districts as Garden East and Garden West. The existing zoning may have to be revised so that intensive exploitation will be facilitated. The present tendency towards low, and rather scattered, permanent settlement in sections of the inner city causes a dispersion of the dwellings of those who work in the centre, which will be a great disadvantage in the future.

The new districts should be prepared for the reception of the section of the population now living in very bad circumstances in the inner city, as well as for the expected increase in the population of Karachi.

Assuming that 300,000 people will be moved from the central city area, that the population will increase by 400,000, and that 100,000 others with no fixed accommodation or who live in the suburbs will be included in the city proper, space must be provided in the new housing districts for 800,000 inhabitants. There are already houses for a part of this number in, for example, the Golimar area, the Housing Societies' area and Malir.

The size of the districts will depend on the density of the population. This in turn will depend on the size of each house or flat and on the number of individuals living therein, and also on the number of houses or flats per acre. The former factor expresses a family's or an individual living space in a

dwelling, and the latter refers to the spaciousness of the residential area. These two standards should not be confused.

In the Master Plan, as a whole, an average living space of one room to every two persons has been calculated, which obviously is far better than the present situation. Thus it may be seen that the Plan assumes a considerable improvement in the standard of space per individual, which can only be achieved in part during the first stage of development. It may be assumed that in districts where the population is in the lowest income group, the average person can again achieve the median standard of 2.75 persons per room that the industrial worker in Karachi had (according to a recent investigation) before the refugees flooded the city at the time of partition. Neighbourhood Units, calculated for 40,000 inhabitants in the Plan, would then have 55,000 inhabitants, or nearly 40 per cent more than what is ultimately contemplated. The living space can, later on, easily be increased through some of the occupants and grown children obtaining homes for themselves, or by combining flats, or extending the buildings—the latter only if they are designed with this in mind.

On the other hand, the standard of space for the houses themselves should not be lowered during the first stage of development since, in contrast to the standard of living, it cannot easily be changed once buildings have been constructed, water and sewerage pipes installed and streets laid out. Experience shows that poor constructions as a short-term expedient, is hard to overcome while the city is growing, even after the economic conditions of its people have considerably improved. Such unfortunate consequences can easily be found in all countries.

It may be pointed out in this connection that an increased population in each Neighbourhood Unit during the first stage, without a change in the planned standard of the unit, will be accompanied by a heavier burden on schools, hospitals, parks, etc., than will be the case later on. This, however, will involve no particular difficulties, since prerequisites for a more developed service will not be available during the first stage.

A location of new districts as close to the present city area as possible, to avoid costly transport, would tend to prevent any interruption in the city's built-up areas and to allow the residential areas to stretch out continuously in all directions where building is possible. Generally speaking, all big cities grew in this way in former times. This, however, runs counter to a planned procedure with a more distant goal in view than the immediate present. A reserve is necessary for the extension of administrative buildings, institutions, the University together with the surrounding national cultural centre, schools, hospitals, parks, sports centres, etc., all of which will require large areas of land in the future and should be centrally located. This should be borne in mind even during the first period of housing construction, and only those districts designated in the Master Plan for this purpose should be built up with flats and houses. It should be particularly emphasized, however, that certain parts of the planned central reserve consist of military areas, such as Mauripur Airfield and Karachi Cantonment, which could be used to advantage as residential districts and for other purposes.

The new districts that should first be considered for building are the Golimar district with its continuation to the north-east, those parts of the Capital south of the Layari River which are not reserved for public buildings, the Housing Societies' area at Drigh Road, Clifton and the district north of Mauripur. Development is already in progress within Golimar, the Capital and Clifton.

The development of the residential area should be limited as shown on the map placed as a frontispiece to this chapter. At this stage, the districts of Malir and Landhi will constitute an independent industrial satellite town. The built-up part of the new district north of Mauripur will soon be utilized for the Trading Estates' workers, while the remaining residential areas are designed to serve

the centre of the city. An intermingling of the population working in industry and in the centre of the city may, of course, take place in the districts north of Mauripur and north of the Golimar area, since both lie about the same distance from the Trading Estate and the Central Commercial Area. It has been assumed that full utilization will not be made of the areas proposed for blocks of flats in the city centre, in Clifton and in the Housing Societies' district, nor that there will be as great a number of occupants in each flat as has been assumed above.

Communications

Whether, in the first stage of the Plan, some of the present tramway line should be transformed into local railway lines and extended to the outer areas of the city will, to a great extent, depend on the standard development and availability of capital funds. In particular, the difficulty of breaking through the already built-up district makes it doubtful whether the lines can be constructed quickly. Since, at this stage of development, distances will still be short enough for reasonably quick passenger transport by buses, it is presumed that the city will be entirely served by bus lines, except where local passenger traffic is taken care of by existing railways. Malir and Landhi already have a railway service which can be developed considerably without being overloaded, even with an anticipated heavy increase in goods and main line traffic. In this connection it should be pointed out that the replacement of the existing tramway system by buses is highly desirable, since the trams are too much of a hindrance to other traffic in narrow streets.

The structure and shape of the city, with the harbour and business district at one end of the densely-populated district, will soon make the present communication system through the area inadequate. The building of the Capital in the other part of the district, and the continual extension outwards of the harbour installations, will cause a further deterioration of traffic conditions.

No large-scale development of the express road system may, however, be considered necessary during the first stage. The construction of certain parts of it, even on a simpler standard in regard to intersections and widths, would quickly help to mitigate the worst bottlenecks in the main thoroughfares. The development of express roads, together with the improvement of the main street-network by widening and by cutting new streets through the blocks, should, however, be preceded by careful traffic analysis.

It should be pointed out that the express road through the capital area can be constructed without great difficulty on the stretch between the Bandar Road Extension intersection and Victoria Road inter-section, and this, together with Havelock Road, should ease traffic on Frere, Bandar, Ingle and Inverarity Roads, as well as on the street system around Saddar Bazar. In the same way the development, at an early stage, of the express road on the south bank of the Layari River, and through the Layari Quarters to the harbour, could ease traffic on Lawrence Road and Bandar Road. This express road would be particularly desirable on the stretch from the harbour to the vicinity of Gandhi Gardens, where for the time being it might be linked with Lawrence Road, the outer section of which has less heavy traffic.

The express road through Golimar can be brought into Frere Road with comparative ease, and should as quickly as possible be connected with the above-mentioned express road through the Capital, as the streets running in a north-south direction in Saddar Bazaar are not suitable for through traffic. Since it is intended that there shall, in the first stage, be a complete development of Golimar and the district to the north, which are primarily designed for those working in the centre of the town, a considerable volume of traffic, at an early date, may be expected on this cross-communication. Another transverse express road, which would be of immediate great significance for traffic in the inner city, is the one that crosses Bandar Road at the Municipal Office. It is particularly needed on the stretch running parallel to Napier Road, where the through traffic must be eased. South of Bandar Road, Kutcheri Road may for the time being replace this express road. In this connection

mention may also be made of the importance of linking New Queen's Road with Bandar Road in the vicinity of the Port Trust Office by a viaduct over the railway station, in order that New Queen's Road, which is practically undisturbed by local traffic, may take over a part of the through traffic on Bandar Road and McLeod Road. Such an arrangement will, however, be both complicated and expensive.

During the first stage, Clifton should be able to manage without an express road, since Clifton and Victoria Roads can handle a considerable amount of traffic.

There is no reason to consider the development, at this stage, of harbour and railway installations, since they have no more effect on the planning of the other areas than has already been mentioned, and since a qualified organization is taking charge of this development.

Next Stages of Development

The housing development of the new districts situated further from the city centre will be dependent on the extent to which the population increases and the standard of living is raised. As the city spreads, the inner communication system in Karachi, as in other big cities, will be of decisive importance for its functional capacity and its ability to offer the inhabitants a pleasant and stimulating life. The demand for quicker and more convenient means of transport with greater capacity to link up the different parts of the city, especially the outlying districts with the city centre, will become greater, and the traffic load in the inner city will increase. With such simple traffic facilities and social conditions as have been outlined in the section dealing with the first stage, there will naturally be a much greater demand for investments in the next stage of development, both for the communication system and for the social services. It must be remembered, however, that production and investment capabilities can be expected to grow enormously at the same time. A period of reckless investment in city construction has characterized the communities of the western countries, ever since industrialization got under way, and there is reason to assume that a similar development will take place in Pakistan when the early difficulties are overcome.

It is impossible, at this time, to state in detail what form the development will take in later stages, nor should it be of great significance, since the permanent planning organization (which should begin its activities as soon as possible) will have the opportunity, as work progresses, to get a clearer view of the situation, and will thus be able to crystallize the ideas contained in the Plan in step with the development of the city.

According to the Master Plan, the new outlying districts are to be built around radial express roads and local railway lines, which will convey traffic to the centre of the city. With the extension of the city boundaries new Neighbourhood Units, normally comprising 40,000 inhabitants will be formed, each served by its own local station. Each Neighbourhood Unit will be connected to the next and the express road and local railway system will be extended by one station at a time; 5 to 8 Neighbourhood Units will form a district of 200,000 to 300,000 inhabitants, served principally by one main road and one local line. When such a district is near completion, a new one will be opened up, and when this in turn has reached a sufficient size, the railway system will be enlarged by an additional line to serve the new district.

Express Roads and Local Railway Lines

The proposed stages of development of the local railway system are shown on the maps on pages 248-250. In the last stage, besides the radial lines, there will be a circular line inter-linking the outer city areas. (In earlier stages of development, the passenger traffic anticipated between the outer areas is assumed to be served by the main line railway which, on the whole, follows the same alignment.)

The system of express roads and local railways is designed to grow continually in length and be

increased by the addition of new roads and lines. The width of the roads and the standards of these and of the local lines should be considered in relation to the stage of development. These standards must be adapted to the amount of traffic as well as to the economic resources available at various periods.

Thus, in the beginning, and as long as the number of motor-cars has not increased to western standards, the express roads should be built with a lower capacity, and for a lower average speed, even if this might imply a lower standard of traffic safety. The local lines should also be constructed initially with a lower capacity than that intended for the final development. Further, it is probable that, for a period, buses will have to substitute for the local lines, if lower wages and the higher cost of construction materials make bus transport more economical for a greater passenger capacity than in the West, or if the necessary capital for constructing railway tracks cannot be obtained, even if such construction should ultimately prove more economical.

On the middle sections of the local system, four tracks are proposed, in the ultimate stage, in order to make possible the use of express trains. In the beginning, however, the lines should be double-tracked only. In spite of this, provided the trains are timed at fairly long intervals, the express train system might be used. According to the plan for complete development, local lines will be laid in two double-tracks parallel with each other through the centre of the city, so that the section there will consist of four tracks. As long as the train interval on each line is not shorter than about four minutes, the two double-lines can each converge onto a single track so that the section through the centre of the city can be initially built as one double-track line.

Disregarding the fact that, to begin with, the railways will thus be provided with double-tracks, instead of with four-tracks, their construction standard should not be lowered on the sections through the centre. Level crossings, there, would reduce the intended capacity, speed and safety. Furthermore, since the proposed lines through the central district are only at a very few places at ground level in the final stage, nearly all stretches within the centre would have to be re-built to the standard laid down in the Plan, if level-crossings are tolerated in the beginning. Practically all the capital invested in line installations would in that way be wasted. The same applies to the express roads through the centre, although not to the same extent, since in the road system it is easier to tolerate level-crossings in the earlier stages.

In the outer districts, both express roads and local railway lines should be constructed at surface level, and on these stretches there will be no problems from the point of view of development. As a rule, the express roads and local railway lines should pass the intersections over viaducts. Different stages of development may be considered in this connection, depending on the nature of the inter-sections.

There should be a local railway station in the centre of each Neighbourhood Unit, but no crossing of, or connection with, the express is contemplated. It is intended that pedestrian and bicycle traffic to and from the station, and between the residential areas on either side of the express road, should pass through a subway, so that neither the tracks nor the main road need be crossed. The cost of the subway will be moderate and its construction should be undertaken at the very beginning of the programme with a view to traffic safety. This should apply even if bus lines instead of local railway lines are used for general communications.

The intersections of the express road and the feeder streets carrying traffic to the Neighbourhood Units are generally to be found half-way between the local stations, at the point where the trains have reached their greatest speed. If, in the first stage of development, the railway lines were allowed to cross the vehicular traffic at surface level, street traffic would be checked by light signals or crossing gates operated either by a crossing-keeper or automatically by the train. This, however, would mean insufficient safety and might cause serious accidents. Therefore, viaducts should, if possible, be constructed at crossings. Crossings at ground level between express highroads and feeder streets must be accepted for a long time to come, provided that the intersections are constructed as roundabouts with effective checking of speed even for vehicles on the express highroad. Such a crossing in the developmental stages is shown in the figure on page 252.

CHAPTER XIV

ADMINISTRATION AND LEGISLATION

The further planning and technical development of Karachi should rest with a special authority, the Karachi Improvement Trust. The Government, assisted by their technical experts in the Central Engineering Authority, would be the Controlling Body, by which all plans would have to be sanctioned. A Court of Expropriation would be the Judicial Body, which should ensure that encroachments on the rights of private citizens made in connection with the development of the city will be adequately compensated.

There should be two categories of plans: the Master Plan, indicating the main lines that future developments are to follow, and Town Plans, indicating in detail how any given area is to be built up.

The trust should have the right to buy up any land that may be indispensable for the development of the city as planned. Rules are laid down for meeting out compensation to the owner of such land.

The ideas and principles set forth in this Master Plan will be of little use unless they are enforced by a legislative and administrative system, so that the city may actually be developed according to plan. The essentials of such a legislative and administrative system would be the following:

1. The responsibility for the planning and technical development should rest with a special authority, hereinafter called the Karachi Improvement Trust, assumed to include representatives of the Government and the Karachi Municipal Corporation.
2. The Trust mentioned under (1) should be directly responsible to the Government; it should be independent financially and have the right to contract loans and to use special grants from the Government to finance its activities. The Working Committees of the Trust might consist of a Planning Section, a Building Section, and a Land Reservation and Real Estate Section.
3. The Planning Section should pursue and intensify the study of the problems discussed in the Master Plan. This will imply a close and continuous study of demographic, economic and social questions of fundamental importance for town planning. The Section should also continue to carry out purely technical investigations, so that it may fix the final layout of roads, systems of communication and sewerage, types of buildings, etc. more definitely than can be done in the Master Plan. In addition, the Section should carry out all the preparatory work which would serve as a guidance for the actual town planning.

Formerly such work consisted primarily of dividing a given area intended for immediate development into streets and sites for housing according to a certain pattern, but this conception of town planning must be rejected as erroneous. Requirements for Neighbourhood Units and private residences must be considered by the town planner from a sociological and aesthetic aspect; the planning of a system of roads must be made with due attention paid to the prevention of accidents; when designing buildings, streets, sewers, etc., economic as well as technical factors must be taken into consideration. Consequently, the Planning Section should consist of, or collaborate with, a large number of experts specializing in different fields.

4. The Building Section should direct and carry out, departmentally or by tenders, all public works, such as the laying of streets and pipes, etc., and, if required, the construction of public buildings, private houses, etc. Its duties as a section of the Trust should correspond to those of the Public Works Department.

5. The Land Reservation and Real Estate Section should be responsible for providing the land required for the rational development of the city. It should have authority to expropriate further land for this purpose, if necessary, and it should administer the real estate of the Trust.

6. The city should, in principle, be developed in accordance with the Master Plan as sanctioned by the Government. In order to be valid, proposals recommending alterations and modifications of the Master Plan should be made and adopted by the Trust and sanctioned by the Government.

7. Before the building up of any area begins, a separate detailed Town Plan for that particular area should be drawn up. It should contain detailed data regarding the future utilization of that area, and show the boundaries of the blocks of buildings and the type of buildings, streets, etc. that it will contain.

Such plans for a given city area should be first approved by the Trust, and then sanctioned by the Government in order to be valid. Less extensive or less important plans and slight modifications in an otherwise valid Town Plan might, however, be sanctioned by the Central Engineering Authority.

Prior to the adoption of a Town Plan by the Trust, the owners of the respective land should have the right to state their views. Their objections—if any—to the plan, with comments thereon made by the Central Engineering Authority, should be available when the Government discusses its sanctioning.

8. Land for which Town Plans have not been prepared should not be utilized for building purposes. After consulting the Trust, the Central Engineering Authority might, however, consent to exceptions from this rule, provided that they do not impede any possible plans for the future development of this area.

9. Once the Master Plan has been sanctioned the Government might, at the request of the Trust, authorize the latter to take over the land that may be required for the carrying into effect of the plan. This rule should apply to ground of any description, irrespective of whether it is intended for private or for public use.

10. Once a detailed Town Plan has been sanctioned, the Trust should have the right to take over the land allocated in the plan to a given street or other public place, or to public buildings, etc. If, in order to facilitate the utilization of the ground for the stated purpose, the Trust should consider it desirable to take over land allocated in the plan to houses, industries or the like, the Government might authorize the Trust to take over such ground at short notice.

11. Compensation to the owner of land taken over by the Trust should be fixed by a special Expropriation Court including among its members, in addition to legal experts, a technical expert versed in matters relating to real estate and town planning. The compensation should be established according to the general recommendations given below.

12. The compensation paid for land taken over by the Trust should correspond to its estimated market value, taking into account the present capital value of the revenue resulting from an authorized future exploitation of that land with due regard to the probable future date of completion of buildings.

Land, which according to the valid plans does not require to be built upon, should be estimated to have no future building value.

13. The owner of land situated in an area that forms part of a detailed Town Plan should, without receiving compensation, surrender to the Trust as large a portion of the ground owned by him as the Court considers to be required for roads, parks or other public places, or for public buildings, in order to make possible a remunerative exploitation of the remaining portion of the ground. Should the Trust simultaneously take over this remaining portion of the ground also, the owner should receive compensation.

14. Land owned by the Trust, but released for private building, should in principle remain the property of the Trust and should only be leased for building on conditions of leasehold. As a rule, such a lease should not exceed a period of 50 years.

Stockholm, April, 1952.

For VATTENBYGGNADSBYRAN (VBB)

(Sd.) S. Lindstrom

(Sd.) B. Ostnas

on behalf of MERZ RENDEL VATTEN (PAKISTAN).

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