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Project No. 206

ABHA Action Master Plans

Technical Report No. 5

Existing Conditions

Volume one

Background Information

Prepared by

Scan Plan SWECO/ARCH Centre

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ABBREVIATIONS

- ISDC Industrial Studies and Development Centre (now Saudi Consulting House)
- SPS Scan Plan SWECO/Arch Centre Consultants
- URTEC Urban Technology Consultants
- SIDF Saudi Industrial Development Fund

NOTE ON TABLES

Figures expressed as percentages are rounded up and need not therefore sum to 100.

The frontispiece (next page) shows a view looking south from the edge of the escarpment at Abha. The jagged mountain ridges here and inland together with the precipitous ascent from below earned Asir its title of "the difficult region". Now asphalted roads connect it to the rest of the Kingdom. The main road to Jizan is in the foreground.

EXECUTIVE SUMMARY

This summary presents in outline the main features of the present pattern of development, and the problems that these raise for the continuing development of the Abha Metropolitan Area. For more detailed information on any specific aspect it is necessary to refer to the four volumes that make up this report.

The Abha Metropolitan Area falls within the Asir Administration District, which itself is the fourth most populous district in the Kingdom after Mecca, Riyadh and the Eastern District. The Abha Metropolitan Area is defined by the commuting sphere of influence to the three towns of Abha, Khamis Mushayt and Ahad Rafidah which all lie quite close together. The only other major town within the District is Bisha which lies some 200km to the north.

Undoubtedly that part of the Asir bordering the escarpment, which includes the Metropolitan Area, has one of the most equable and pleasant climates of the Kingdom. It is the one area with any serious potential for rain fed crops, though this has recently been badly affected by the lack of rains. The climate and the dramatic scenery both help to create a potential for tourist development second to none in the Kingdom. Actual tourist development though is still in its infancy, and at the moment makes a negligible contribution to economic development. Development in the past had been held back by the relative isolation of the Asir, an isolation which would still appear to persist in the minds of many people who live outside the region.

Within the Metropolitan Area society is adjusting to a change from a nomadic and agricultural life style to one influenced more and more by the towns. One third of the total population of 150,000, or just under half of all Saudis, live in the rural areas. The interesting feature at the moment is the number who farm their family inheritances in the afternoon after they have finished their daily work in the towns. People display an ardent attachment to the land but the size of the holdings is diminishing all the time due to the system of inheritance and the lack of any new land to bring under cultivation.

The two towns of Abha and Khamis Mushayt are respectively the administrative centre and the major commercial centre for the Asir District. In terms of urban occupations the Saudis are overwhelmingly concentrated in administration and the military sector, the latter in connection with the military bases at Khamis Mushayt. A squatter settlement of zinc huts to serve the military complex has grown up on the east side of Khamis Mushayt.

As is common with the Kingdom at large the industrial and manufacturing base is almost entirely reliant on foreign labour. The age-sex pyramid for the non-Saudi population displays the classic form for an immigrant community where male migrants form the majority. Approximately one fifth of the urban population is non-Saudi, while practically all the rural population is Saudi. The importance of the non-Saudi labour force can be gauged from the fact that in the urban areas within the age group 25-29 there are as many non-Saudi males as Saudi males.

*Trend in the towns dwellings with fewer rooms*

The recent population growth is derived from an annual natural increase of 4.2% and 1% net in-migration for the Saudi population, and a likely 5% net in-migration for non-Saudis. The growth in the non-Saudi population is determined largely by labour demand, especially for that in the construction industry. The prospects for non-Saudi nationals in the Metropolitan Area is very much dependent on what the official policy will be as regards the role of non-Saudi nationals.

The impetus to development has come from government expenditure and the multiplier effects of this on the demand for provisions, services and housing. The most striking evidence of this expenditure is the enormous increase in administrative posts and the creation of the military complex at Khamis Mushayt. It is estimated that almost half of all the jobs in the Metropolitan Area are directly paid by the government being payments to 65% of the resident rural workforce and 45% of the urban resident workforce.

Of necessity in the early stages of development priority has had to be given to the standard of physical infrastructure. Accompanying this there has been a significant expansion in the private home building sector. The role of the Real Estate Development Fund with its loans has been of crucial importance in permitting the rapid expansion of housing. Figures for the rate of new housing show that the capacity of the building industry has been sufficient to keep pace with population growth and help provide better accommodation for everybody. Two adverse trends though are noticeable. Housing and land speculation has been increasing rapidly with a consequent leap-frogging effect on development and probably an increasing proportion of construction activity being devoted to an already affluent minority. The second adverse feature is an apparent trend in the towns dwellings with fewer rooms



The Metropolitan Area has at the moment only a weak manufacturing and industrial base. Employment in this sector is heavily dependent on construction, vehicle maintenance, repair and car sales. Clearly it is unsatisfactory for this sector of the economy to be based so much on car ownership and the changing fortunes of the construction, industry. A decline in private sector construction, for example, could have widespread effects. The most effective way to raise peoples' living standard without requiring a constant drain on government finance is to improve productivity in agriculture and industry. The problem, therefore, is to decide how best to promote private investment which will help the development of the economy without compromising the attractive features of the area. In the future progress may well be judged by how green and pleasant the area remains.

Issues

This report contains information regarding several issues that must be resolved if the population is to continue growing at its current rate and the land be developed in a sensible and economic way. The appraisal of these issues is a matter for Report No.9, but they are listed here because background information regarding them can be found in this report.

The issues are either mainly of a quantitative or of a qualitative nature. Those of a quantitative nature include:

- (i) Water - Studies made show that demand is running dangerously close to the maximum yield of the water resources. There is no margin for either a run of dry years or for any significant population increase.

- (ii) Suburban development - Large amounts of land have been staked for development alongside the main roads between Abha, Khamis Mushayt and Ahad Rafidah. It is almost entirely for industrial purposes and the amount so far claimed exceeds the existing built-up area of Abha. Such development appears to take place without any formal planning approval; and the fragmented pattern of development makes it difficult to extend the infrastructure effectively.
- (iii) Labour force and industrial development - Self-sustaining growth depends on a diversified economy with the emphasis on the development of the manufacturing sector. At the moment the Metropolitan Area is represented in only one of the five sectors that are considered by the Saudi Unindustrial Development Fund. Several factors can help to explain this, including the small size of the local market and its relative isolation. Arguably the greatest need is for skilled vocational graduates and the promotion of sound commercial investments. Many people have left Asir in the past but could be expected to return if the job prospects improve. A new industrial city and university have been agreed upon in principle for the Metropolitan Area.
- (iv) Land conservation - In order to secure the availability of land for future development both within the planning period and beyond period, measures shall be taken to protect government land from unauthorised. This applies especially to the large area south of Abha Airport.
- (v) Development of tourism - Measures of a quantitative nature regarding tourism should be to arrange for accommodation on the history, natural features and cultural aspects of the area.

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The sense of urgency given to the issues of a qualitative nature depends on a subjective judgement of the present danger and a consideration of how critical the issue would become if present trends continued unchecked. The more important of these qualitative issues would appear to be:

- (viii) Neighbourhood design and amenity protection. - It is an ancient Islamic precept that certain zones in and around urban areas should be kept free from development in order to maintain a healthy and attractive environment. An attractive environment has also been achieved by the traditional housing design which helped create a strong sense of neighbourhood identity with a clear distinction between public and semi-private space. In contrast to much of the traditional development with its considerable visual interest and variety, contemporary development is usually depressingly uniform in appearance. The problem is to retain the vigour and variety of traditional design in a contemporary idiom, and satisfy the modern requirement for car accessibility at the same time. Neither the town nor the neighbourhood area should be considered complete without attention being given to safeguarding attractive open areas within the towns, especially. The wadis have a unique potential for open air recreation, but the problem here as elsewhere is to find ways of safeguarding them in the public interest against unsatisfactory private development.

(vi) The protection of sensitive areas - One of the major assets of the Metropolitan Area is its scenery. A major issue is how to arrange for modern development in a way which will not compromise these scenic qualities. Already a National Park has been designated but the direct alignment for the proposed desalinated water mains and electricity grid passes right through the middle. Planning Authorities can give guidance on the form of development, approve subdivision plans and effectively withhold any government grant if the development is not approved, but the right to restrict the freedom to develop in the public interest without providing some form of compensation is not generally accepted. The result of this is that a prospective developer can do as he likes if he both owns the land and has no need for a government loan.

(vii) Conservation of cultural heritage - The validity of architectural conservation is still not generally acknowledged, but it is a fact that examples of the Asir vernacular architecture form a distinctive contribution to world architecture. The historic cultural tradition is most evident in the rural areas among the hundreds of small villages. It is the effect of all the villages in aggregate that is most pleasing, but there are too many all to be made into museums. If as seems likely many of the rural families would prefer to live in modern houses guidance must be given on how to make sympathetic alterations, or imaginative new uses must be found for the buildings. Without this the villages could easily become ruins or lose their character.

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CHAPTER 1

INTRODUCTION

This report is the fifth in a series prepared in accordance with Agreement No. 206 between the Ministry of Municipal and Rural Affairs and Scan Plan Coordinator A/S in joint venture with SWECO and Arch Center.

The purpose of this report, which comprises four volumes, is to provide the basic survey information that is necessary for the studies on the Master Directive Plan, Execution Plan and Action Area Plans. As such it helps to fulfill the requirements in the contract for updating planning data and wherever possible making comparison with previous studies to indicate current trends.

The objectives for municipal development spelt out in the Second Development Plan are extremely broad in scope and involve many agencies besides the Ministry of Municipal and Rural Affairs. The aim is to make cities, towns and villages healthier, more comfortable, more enjoyable and less costly places in which to live, work and travel and, at the same time, to improve their efficiency as locations for trade, industry and services. This involves, for example, the Ministries of Education, Health, Industry and Electricity, Youth Welfare and Communications who each have their own budgeting programme and policy objectives. The Ministry of Municipal and Rural Affairs is responsible for coordinating development to help bring about these planning objectives of the Second Development Plan. Its detailed responsibilities include contracts for sewerage and roads, but its most

(1)

*Ministry of Planning, 1895(1975), Section VII(C) P. 493*

(1) Second Development Plan, Kingdom of Saudi Arabia,

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in preparing municipal development plans and through town planning offices approving plans for subdivision areas. It is accordingly important to appreciate what effect the national and regional policies of the various ministries will have in securing the general objectives for municipal development, and to be able to indicate their land use implications. This the report attempts to do in its land use and sectoral studies.

An important part of the economic base within the Metropolitan Area is the agricultural sector. This has been made the subject of a separate study which appears in Volume 2, though the rural areas are also referred to as appropriate in the description of the distribution of facilities.

This report has been divided into four volumes:

Volume 1 - Background Information

General information on natural features.  
Detailed description of socio-economic survey.

Volume 2 - Demographic and Economic Information

Socio-economic material and economic analysis.

Volume 3 - Land Use and Physical Development

Land use analysis and distribution of community facilities and public utilities.

Volume 4 - Transportation

Analysis of existing situation.

The chief concern in the preparation of the report has been to assemble information in a way that permits comparison with past studies and which is capable of being updated as occasion demands. The major sources of information have been a comprehensive socio-economic survey on a 5% sample of the population, a land use survey which involved a complete inventory of buildings in the towns (Abha, Khamis Mushayt and Ahad Rafidah).

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an agricultural survey determining a general soils classification and details of crop production, an industrial survey and lastly information from discussion with officials. A survey of wells within Abha and Khamis Mushayt gave some background data concerning the water consumption and amount of water extracted. The majority of this information was collected in 1397-98h (1977-1978).

### 1.1 THE METROPOLITAN AREA

The Abha Metropolitan Area lies within the mountainous Asir, (literally "the difficult region"), and consists of the two major towns within the Asir Administrative District, Abha and Khamis Mushayt together with Ahad Rafidah. The three towns lie quite close together with good road communications between them. The boundary to the Metropolitan Area has been drawn to include the rural population dependent on the towns for local services. It is generally 15-20km away from the towns except where the escarpment forms a natural boundary.

The Metropolitan Area covers almost 1,900km<sup>2</sup> of which only some 17km<sup>2</sup> are presently urbanised. The total population was some 153,000 in 1398h (1978) of which some 66% were in the three towns of Abha (40,000), Khamis Mushayt (55,000) and Ahad Rafidah (3,000). The remaining rural population (55,000) is scattered in many small villages distributed among the terraces or cultivable wadis that help make this area one of the most picturesque in the Kingdom.

Traditionally agriculture has been the main economic activity but today less than half of all rural households rely on it as their main source of income. The small fields and narrow terraces cannot be made productive enough to ensure that agricultural incomes can keep pace with rising urban living standards. The traditional agricultural practices are therefore likely to disappear in the future and a way

of life change. The majority already commute to the towns for work, which are now expanding rapidly as commercial and administrative centres.

The present emphasis on development in two centres helps reduce congestion and permits an easier land market to develop while still allowing a reasonable choice of jobs convenient to the labour force.

The natural scenery, especially around the escarpment on the west is dramatic and tourism can be seen as becoming much more important in the future. Already practically all the escarpment within the Metropolitan Area has been included within the Asir National Park. To the east the countryside is heavily eroded portraying jagged relief and isolated and lonely wadi valleys. Further towards the interior of the country the flat, gently sloping desert plateau becomes dominant. Asir has traditionally been one of the most isolated parts of Saudi Arabia, but with the improved road connections to Jizan and Taif and its increasing importance as a strategic military centre it has begun to participate in the rapid urbanisation common to the rest of the country.

The position of the Metropolitan Area in relation to the other major towns of the Kingdom, the national highway network and the Asir emirate is shown in Figure 1.1. The boundaries of The Metropolitan Area major settlements villages and the road network are shown in Figure 1.2.



- Asir Emirate
- Abha Metropolitan Area
- Major roads existing
- Major roads under construction

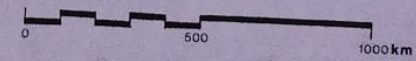


FIGURE 1.1  
REPORT 5.1

LOCATION OF ASIR AND  
ABHA METROPOLITAN AREA

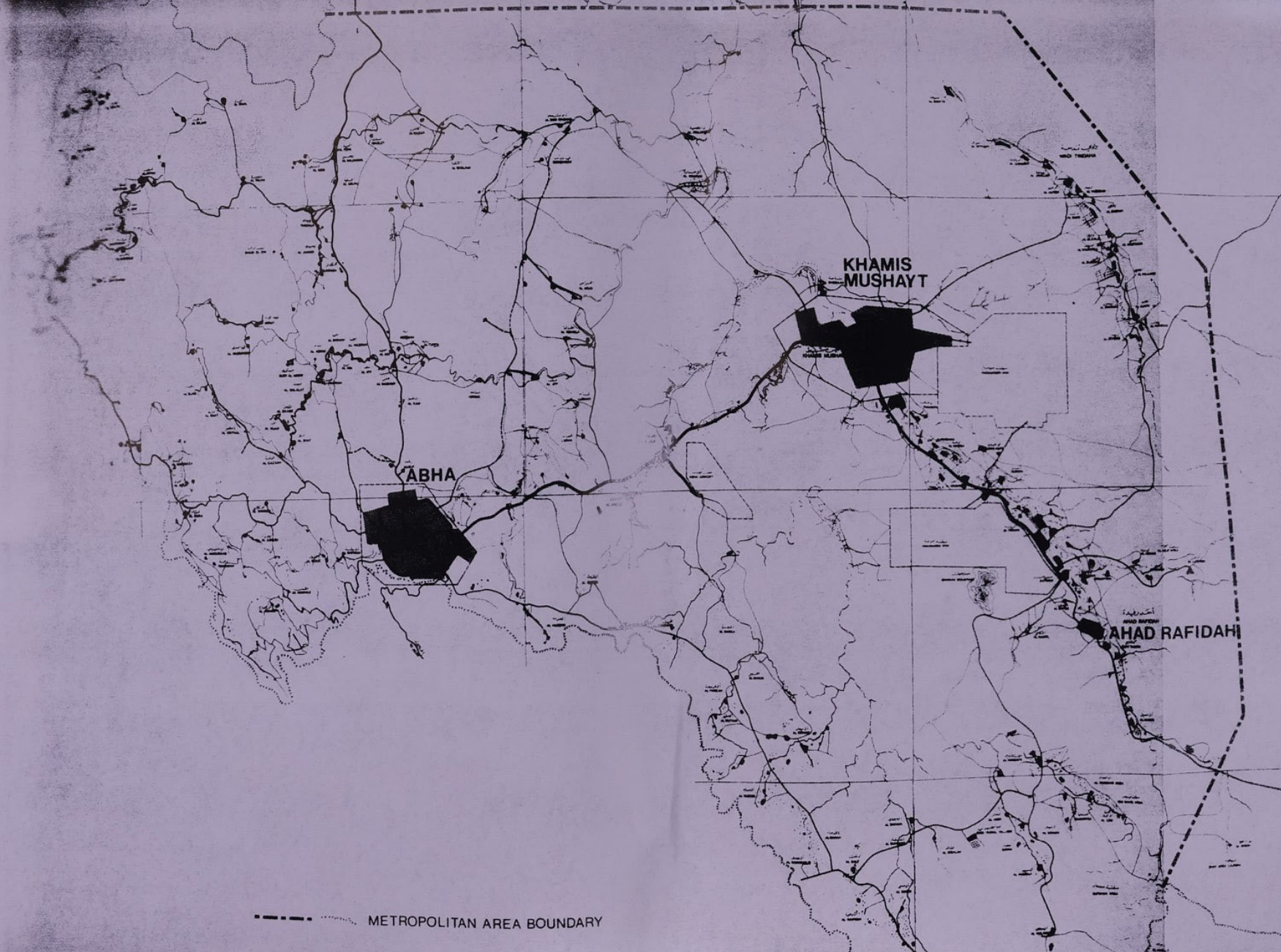
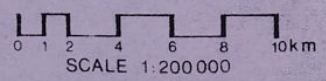


FIGURE 1.2  
REPORT 5.1

ABHA METROPO-  
LITAN AREA



--- METROPOLITAN AREA BOUNDARY

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The purpose of this volume has been to collect together basic background information relevant to the report as a whole. A summary of the surveys that were mounted also appears in addition to a detailed theoretical and practical description of the socio-economic survey.

In Chapter 2 the settlement patterns of urban and rural areas are presented. In Chapter 3 natural features of the area are presented and Chapter 4 and 5 deal with the socio-economic survey and other surveys.

The questionnaires used in the socio-economic survey and transport surveys are shown in Appendices 1 and 2.

CHAPTER 2

SETTLEMENT PATTERN

2.1 DEVELOPMENT OF THE URBAN AND RURAL SETTLEMENT

Early travellers remarked on the fact that in moving south through Arabia it was not until the Asir was reached that settled tribes became the predominant element in the population. The reason was simply that here the countryside could support a settled population, characterised by small villages with chains of dependent farmsteads along the valley bottoms. The villages served as nuclei for the tribes, whose boundaries were usually very sharply defined, and on whose fringes unsettled clans would be tolerated as nomads.

Abha and Khamis Mushayt were always known as important centres. As long as each tribe tried to be self-contained and jealous of its land it is unlikely that much trading could take place when each tribe exacted a toll for the passage of goods over its land. Because of this it is interesting to note that Abha was one of only four villages within the whole of Asir where all the neighbouring tribes could collect for a four month's struce around harvest time to exchange goods from other regions, and perhaps buy and sell land.<sup>(1)</sup> As a result such centres started to collect a mixed population.

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(1) Sir Kinahan Cornwallis, "Asir Before World War I" Reprinted by Oleander-Falcon Press, Cambridge, England, 1976.





The solid appearance of the traditional Asir house helps make a satisfying picture of farmstead and field along the Wadi.



However agricultural decline and abandoned houses are apparent in certain areas. This abandoned farmstead is in part of Mahala where lack of water has forced a reduction in cropland.

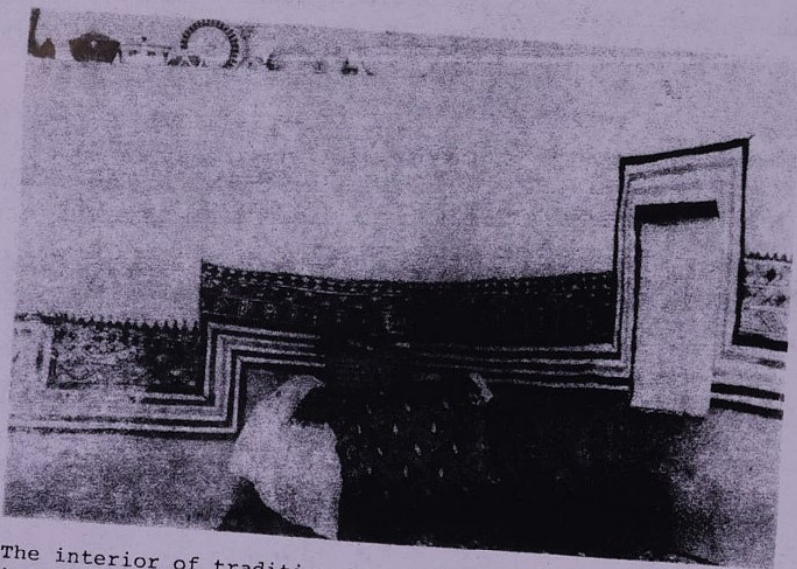
17

Writers and travellers have spoken lyrically of the well watered valleys, and in particular of Khamis Mushayt with its cereals and fruits which were produced in abundance there. The fertility of the wadis was in marked contrast to the dusty intervals of steppe on the plain, and the dry mountain ridges which could only offer a lean pasture. The simple defensive towers, or Qasaba in arabic, which could either be used as lookouts or temporary refuges, are scattered between the wadis and show how frequent petty raiding must have been.

The distribution of villages now must be much as it has been for generations. There are no signs at present of villages being completely abandoned, though in certain places large numbers of buildings are lying derelict, as in Mahala. In certain areas, (Figure 1.1) a cover much of the countryside north of the Abha-Khamis Mushayt road, traditional buildings look well maintained without any modern cement block additions, but in the majority of cases there are signs of a rapid transformation as people build cement block houses and abandon their old farmsteads. But it is surprising how many people seem to regard the new construction as inferior to the old, saying that is too cold in winter and too warm in summer. The drawback of building in traditional materials is that they require heavy labour input, and in the case of mud, lack durability. Examples exist elsewhere in the Kingdom of construction using a mud-cement mix which increases its durability, and it might be worthwhile to encourage such experiments in the Metropolitan Area.



The historic cultural tradition is found in the countryside where landform, fields and buildings all relate to each other. In this picture of part of Tindaha the whole attraction of the village would be lost if the fields disappeared and only the buildings were preserved.



The interior of traditional houses are enlivened by the bold, colourful and vigorous decoration. The women of the household are responsible for choosing and carrying out the plan of decoration. This is the corner of a majlis from a house in Tamania.

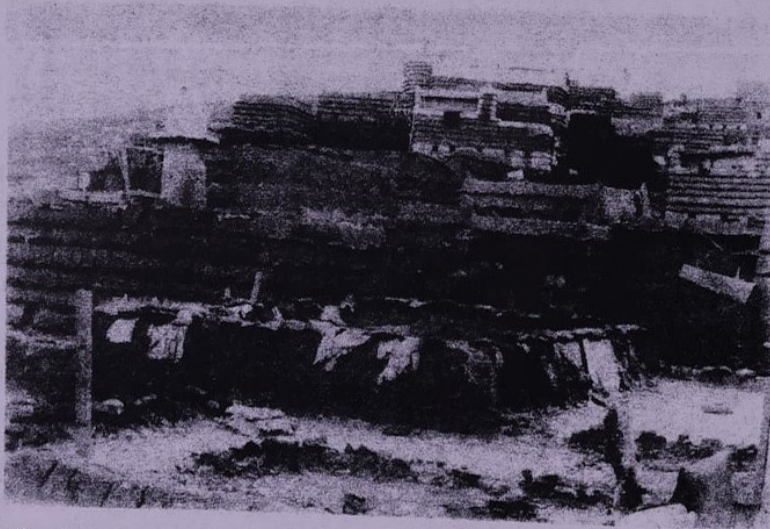
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There is a surprising uniformity in the size of the villages over much of the area, with the majority having from 30-50 houses. In the case of wadi irrigation one might expect the farmsteads to be scattered and related closely to the position of wells, but this is not the case and villages consist frequently of a cluster of houses on some level ground close to but not encroaching on the agricultural land. In the mountains and hills there are some impressive looking villages where the houses buttress each other to rise like a citadel above the fields. The villages here are defensive in character, which is in marked contrast to the pattern of development in other terraced areas in Asir, such as behind Jizan where the farmsteads are much more scattered being built into the hillside at regular intervals along the terraces.

The vernacular architecture in the Metropolitan Area uses local materials to portray a pleasing and convincing response to the needs of shelter and a home. Its design is calculated but not ostentatious, harmonious yet not appearing too contrived. The internal arrangement satisfies the cultural requirements of Islamic society, while the traditional construction of thick walls of either mud or stone and small windows ensures comfortable conditions in summer, and with a charcoal brazier in the hearth, warm conditions in winter. Decoration is effective but discrete. Coloured bands on the mud walls or a pattern of quartz work above the lintel help to accentuate the window openings. Doors are often carved and the walls sometimes have vertical drains of lime plaster with strongly moulded patterns just below the roof. On certain mud houses there are distinctive courses of slates projecting beyond the wall and acting as a plumage to deflect the rain and thus help to avoid erosion of the mud wall.



In many countries it is being realised that historic architecture is a powerful link between the past and the present. These imposing traditional houses in Tindaha stress the continuity of an Islamic tradition.



The rural areas contain much of historic importance. The mosque of this village is reputed to be over 200 years old. Living conditions in the traditional buildings are cramped and difficult in comparison with the new cement block houses being built on plots outside the village. Because of this many of the traditional houses are being abandoned and a social structure is being modified.

Looked at individually each house may appear quite modest yet the pattern in aggregate creates a strong impression. In the wadis the buildings rise distinctively from out of the greenery, while among the rugged mountains they reinforce the bold silhouette of the hilltop.

Although reminiscent of vernacular architecture in other countries the Asir house should be recognised as a distinctive contribution to world architecture.

Studies are already in progress in other parts of the Kingdom to record the principles behind the design of vernacular architecture<sup>(1)</sup> and it is being realised how an appreciation of these principles can help create a satisfying present day environment, while the utility of the houses themselves can be improved by sympathetic improvements to bring them up to an acceptable standard of plumbing and hygiene. A description of typical house plans is provided in Volume 3 of this report.

Although Arabia has exerted a considerable fascination on visitors, no reliable documentary evidence exists on social practices and agricultural development in this area. The area would probably have grown an agricultural surplus to barter with the Bedouin tribes in exchange for their goods, and it is likely that the local craft industries have always thrived here: basket making, pottery and simple leather goods. It is also significant that there is nothing approaching a landless class in this area. Population pressure never seems to have been so great as to cause this, and the system of equal share in the inheritance has meant that all families own some land. It is noticeable from the socio-economic survey though (Volume 2) that only thirty per cent of the households grew crops for cash. For most people the size of the fragmented holdings does not allow them

(1) See for example "Traditional Housing Case Study Buraidah (Oassim)" by Abdul Aziz Aba Al Khial in

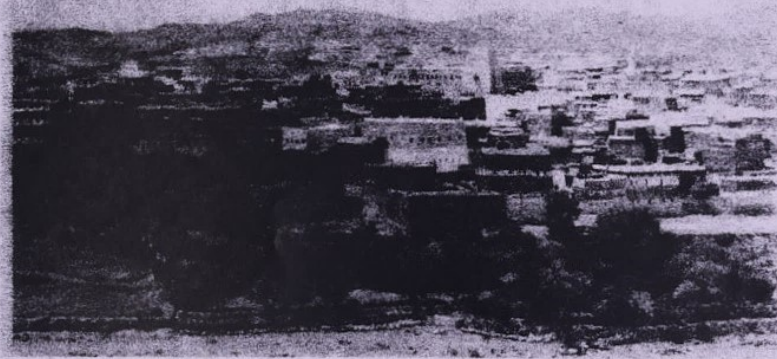
to cultivate enough to earn a living from their land.

## 2.2 PRESENT URBAN AREAS

A comparison can be made between the physical appearance of the three main villages in 1370h<sup>(1)</sup> (1951g) when their appearance could hardly have altered from what it had been for generations before, and the present day. Figures 2.1 and 2.2 compare the distribution of agricultural land, buildings and tracks, then and now, relying on evidence from aerial photographs taken in 1370h (1951).

In the case of Khamis Mushayt there appears to be hardly any change in the amount of irrigated land, except for certain parts which have been abandoned beside the track to Tindaha on the east bank of Wadi Bisha. Tracks to Abha, Bisha, Tindaha and Ahad Rafidah are all prominent, showing how important Khamis Mushayt has always been as a focus of routes. The original track to Abha avoided the present road alignment, aiming instead for a more northerly crossing of the wadi. Surprisingly there are no buildings at the actual focus of the routes at Khamis Mushayt, perhaps because the area was reserved for a large market place with space for temporary encampments. Present day Khamis Mushayt is on the site of two villages, the land between them now being occupied by the Suq. Hardly any of the original village buildings remain, just one or two of the original Asir buildings can be seen near the Mosque, Al Masjidel Kabeer.

(1) Abha, Khamis Mushayt and Ahad Rafidah which at that time were villages



Abha around 1370h. An impressive picture of the distinctive Asir houses clustered around the fort and open square.



Abha today. The vantage point is the same as in the top picture. Only the tower of the fort, mosque and hills are still recognisable. The open square is now the site

At Abha, the present roads faithfully follow the alignment of the historic tracks. Three of the villages along the wadi are still surprisingly intact, but the original centre surrounding the arab fort has largely been razed. As at Khamis Mushayt there is a prominent open market space which now contains the new Suq and Emirate buildings, but in large measure it is still open.

The agricultural areas have been greatly reduced. The only remaining extensive areas of farmland within the ringroad, which are now of great significance, are in the two main wadis and in the south western sector of the town. An especially sensitive area lies to the west of the original town centre. Here the land is still largely in its original state and because it is the largest area of undeveloped land close to the centre it is of special significance.

In Ahad Rafidah there has been hardly any encroachment on the agricultural land, (Figure 2.3). A market is still held on Sunday but it is only a shadow of its former self and the town has declined in importance relative to Abha and Khamis Mushayt. It is significant though for the range of its educational facilities and has the highest percentage enrolled in schools of anywhere in the Metropolitan Area. It is important as an administrative centre and new municipal offices have been constructed beside the main road to Najran. The main road has left the old village undisturbed but strip development has been allowed to spring up alongside it making the traffic conditions dangerous and resulting in a high number of traffic accidents.

FIGURE 2.1  
REPORT 5.1  
THE GROWTH OF  
KHAMIS MUSHAYT  
1370-1398h  
(1951-1978)

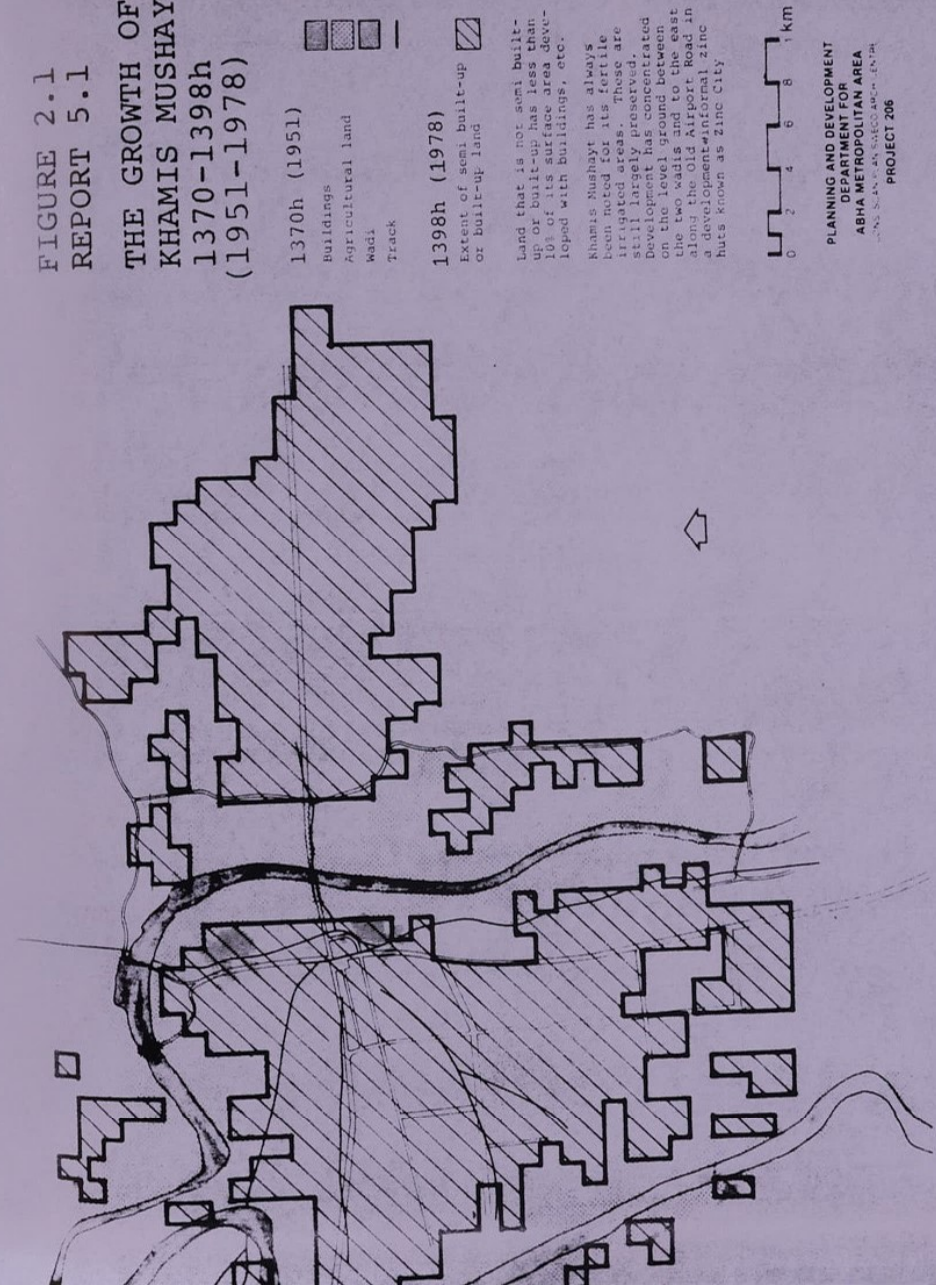
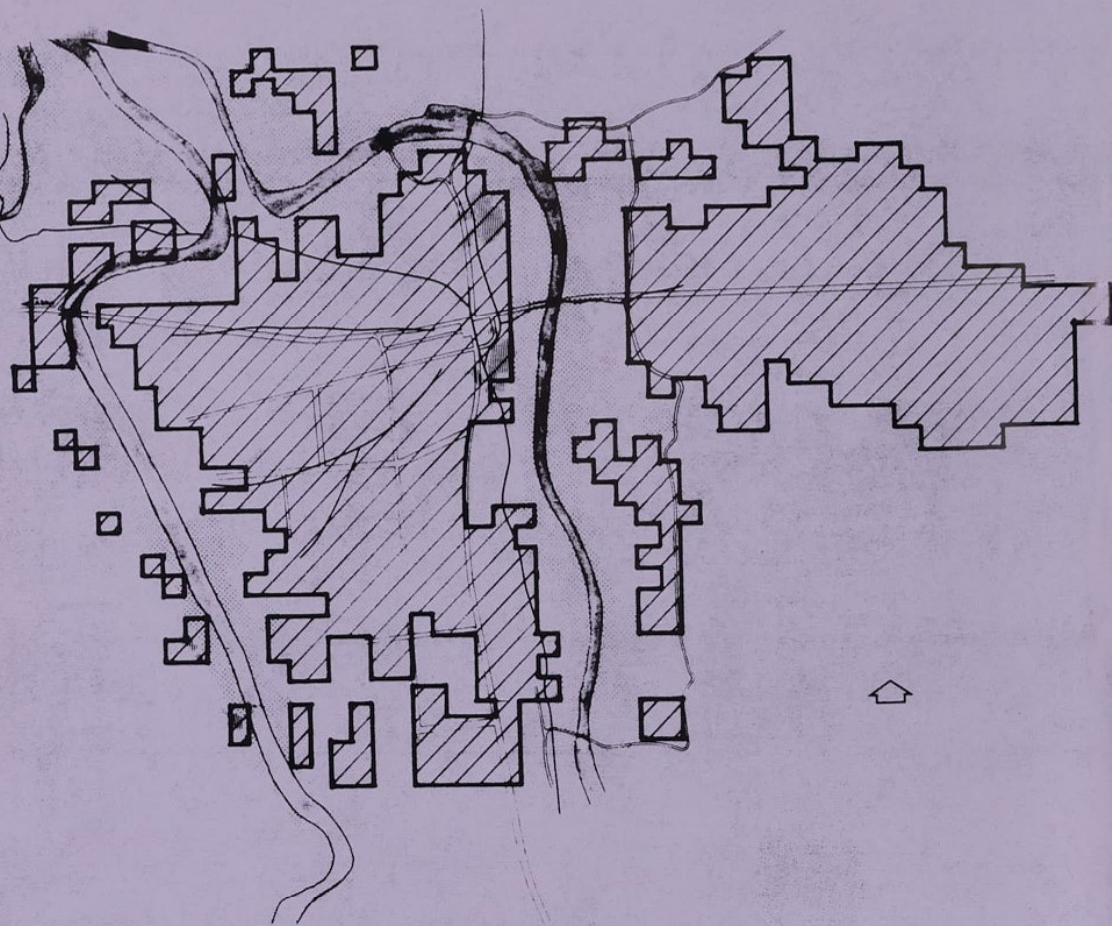






FIGURE 2.1  
REPORT 5.1


THE GROWTH OF  
KHAMIS MUSHAYT  
1370-1398h  
(1951-1978)



1370h (1951)

Buildings   
Agricultural land   
Wadi   
Track 

1398h (1978)

Extent of semi built-up  
or built-up land 

Land that is not semi built-up  
or built-up has less than  
10% of its surface area developed  
with buildings, etc.

Khamis Mushayt has always  
been noted for its fertile  
irrigated areas. These are  
still largely preserved.  
Development has concentrated  
on the level ground between  
the two wadis and to the east  
along the Old Airport Road in  
a development of informal zinc  
huts known as Zinc City

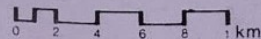
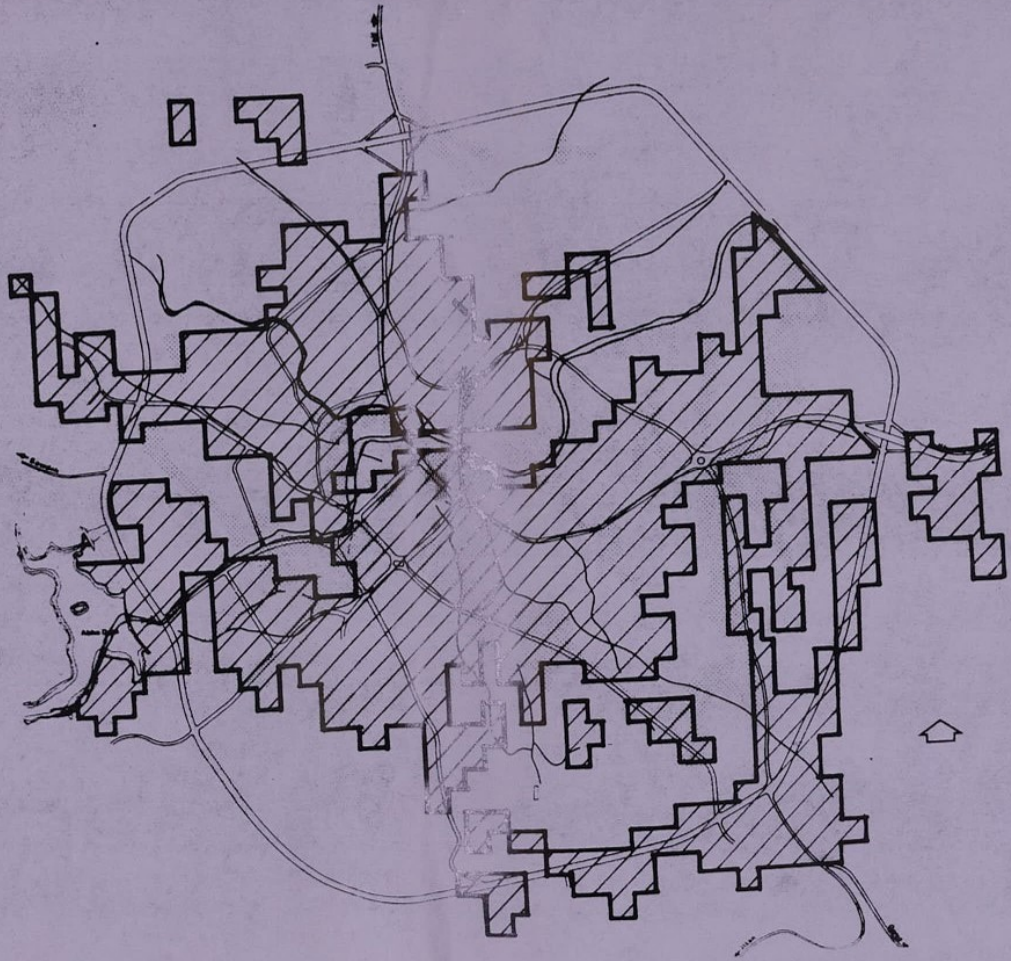





FIGURE 2.2  
REPORT 5.1  
THE GROWTH OF  
ABHA  
1370-1398h  
(1951-1978)




1370h (1951)


Buildings 

Agricultural land 

Wadi 

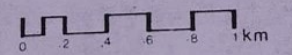
Track 

1398h (1978)

Extent of semi-built-up or built-up land 

Land that is not semi built-up or built-up has less than 10% of its surface area developed with buildings, etc.

The importance of Abha as an agricultural centre has been lost, but the agricultural villages still remain preserved to a remarkable extent within the present built-up areas. More so than in Khamis, development in Abha is fragmented and piecemeal though consolidation is occurring



PLANNING AND DEVELOPMENT  
DEPARTMENT FOR  
ABHA METROPOLITAN AREA  
CONSULTING ENGINEERS ARCHITECTS  
PROJECT 206

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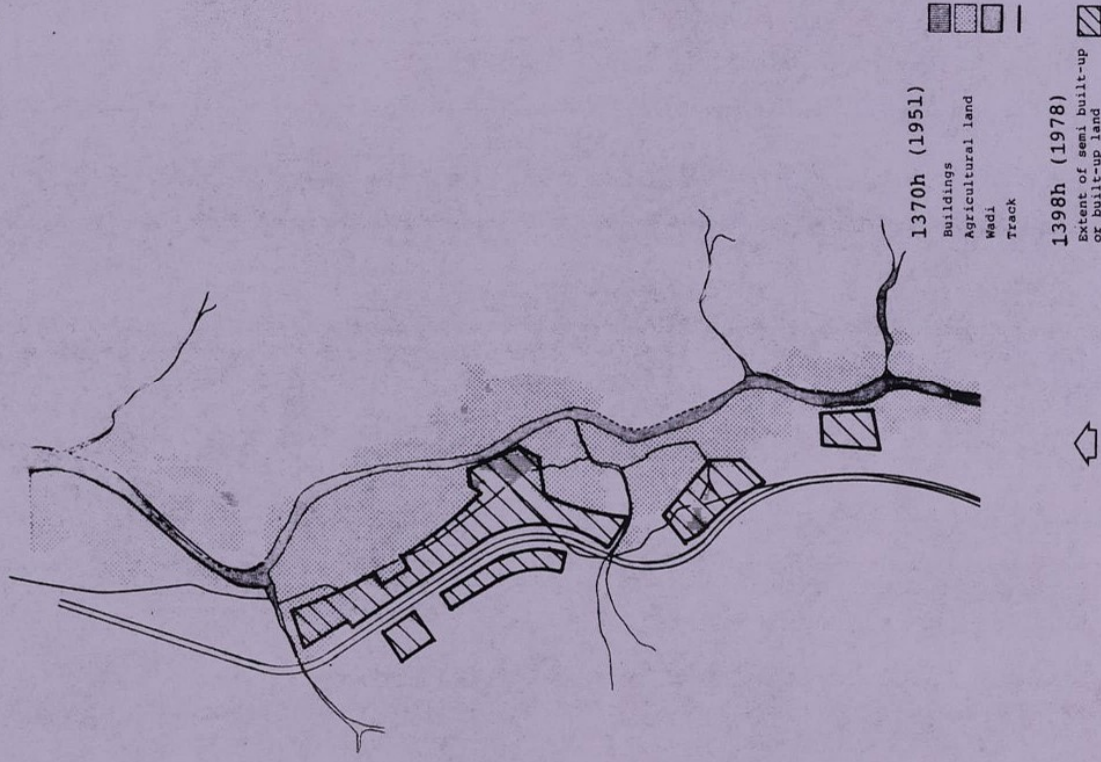
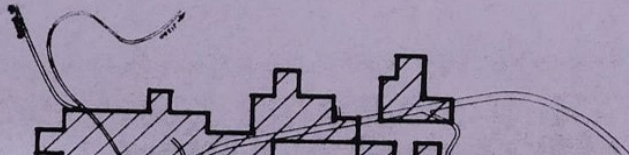


FIGURE 2.3  
REPORT 5.1

THE GROWTH OF  
AHAD RAFIDAH  
1370-1398h  
(1951-1978)

PLANNING AND DEVELOPMENT  
DEPARTMENT FOR  
ABHA METROPOLITAN AREA  
LONG RANGE PLAN - MECO ARCH-CENTRE  
PROJECT 206

PLANNING AND DEVELOPMENT  
DEPARTMENT FOR  
ABHA METROPOLITAN AREA  
PROJECT 206  
0 1 2 4 6 8 1 km





3.1 TOPOGRAPHY AND GEOLOGY

The outstanding topographic feature of the Metropolitan Area is the escarpment which forms its western boundary and stretches north-south parallel to the Red Sea reaching heights within the Metropolitan Area of over 2,000m. The general range of mountains and foothills associated with the escarpment is called the Hijaz, which in general is composed of granite and schists.

In the western part of the Metropolitan Area the rocks are mostly schists derived from sedimentary deposits while in the east granite and gneiss predominate. Wadi Tindaha is an exception to this because the bedrock is an amphibolite schist of sedimentary origin among the granite. The geomorphology of the area is associated with the intense activity that occurred when the Red Sea rift valley was formed, and the Arabian plate composed of very ancient pre-cambrian rocks was tilted upwards with the western edge being highest. At the same time volcanic activity deposited lava flows and caused very intensive regional metamorphism resulting in partial magmatization and granitization of the original sedimentary formations.

On the steep slope of the escarpment the greenstone lava flows are deeply dissected by valleys draining to the Red Sea. Major metamorphosis of the sedimentary bedrock has occurred to the east on the dip slope. Around Sawda schists derived from the greenstone outcrop. They are

easily eroded and weather to produce fine textured soils useful for agriculture. Further inland the extensive areas of granite and granodiorite display occasional bold outcrops of deeply fractured rock with boulders scattered around their base. The large diurnal temperature changes cause this spalling of the rock.

The quaternary is represented by pebbly sandy alluvial deposits and two sets of terraces. The lowermost terrace would seem to correspond to a period of active erosion in the wadis and hence a much wetter climate. In places the present system of wadis is complex suggesting that during this wet period river capture was pronounced and the drainage pattern was undergoing extensive adjustment. The alluvium is not very thick, varying from a maximum of five metres to nothing where there is only a shallow channel over the granite and granodiorite. Figure 3.1 illustrates the general geology.

### 3.2 CLIMATE

The Metropolitan Area lies within a great arid zone which stretches over all the main land masses of the northern hemisphere between latitudes  $30^{\circ}$  and  $35^{\circ}$ . Over the desert conditions are harsh and uncompromising but the Metropolitan Area secures welcome relief from this because of its altitude and orographic rainfall. The typical desert characteristics of a high diurnal temperature range and clear skies with the associated glare and searing sun are reduced in the Metropolitan Area by its occasional cloud cover and the cooling effect of the altitude. The nights are cool, sometimes cold, and the intensity of moonlight and starlight can make night-time especially attractive in comparison with the oppressive heat of daytime in summer.

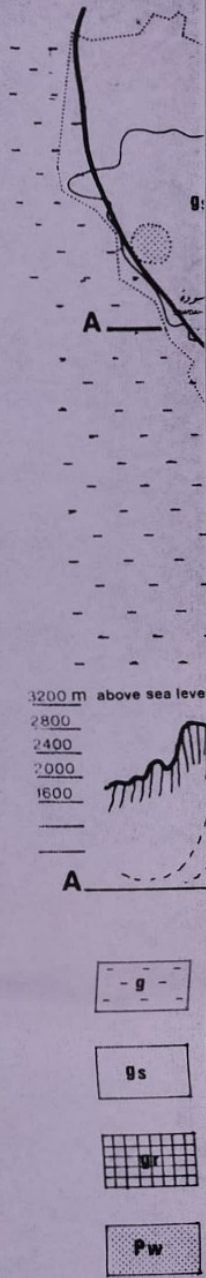
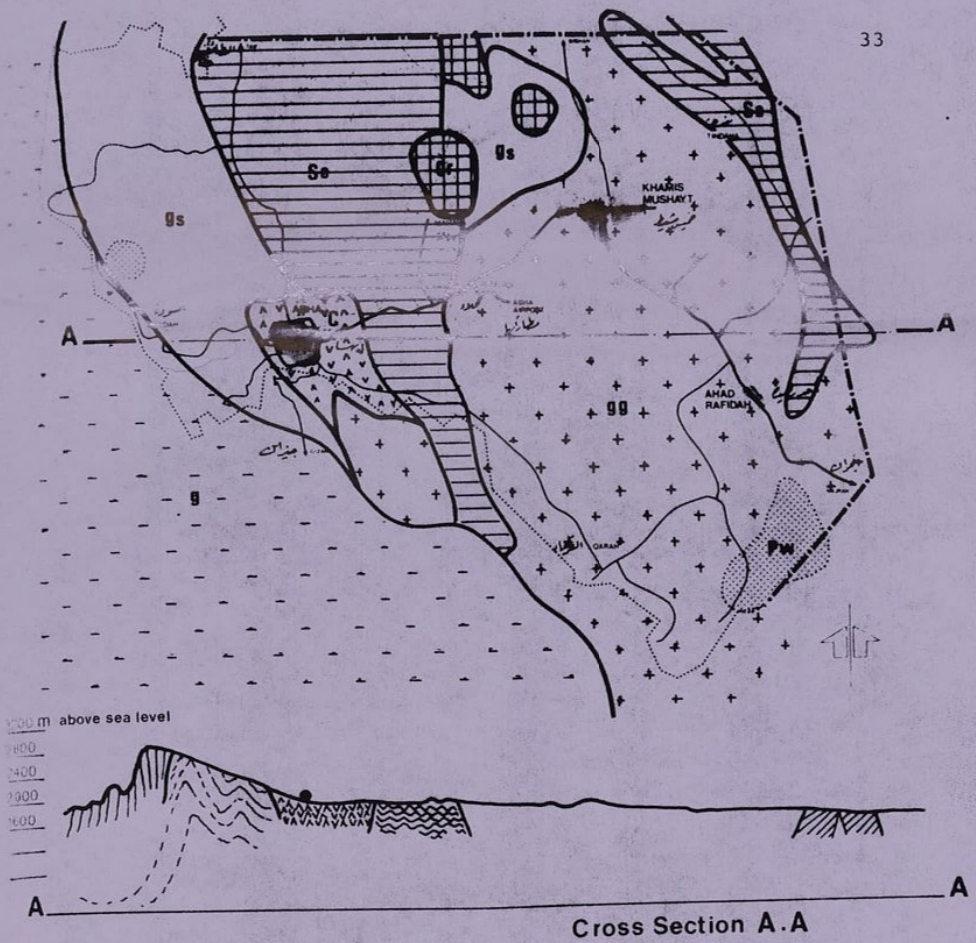


FIGURE  
REPORT  
GENERAL



1200 m above sea level

800  
1200  
1600

Cross Section A.A

- |  |                        |  |   |
|--|------------------------|--|---|
|  | Greenstone pillow lava |  | Granite and granidiorite  |
|  | Greenstone schist      |  | Chlorite-sercite schist<br>amphibolite schist sedimentary<br>origin |
|  | Granite                |  | Complex intermixed granite<br>diorite gabbro and amphibolia         |
|  | Wajid sandstone        |  |   |

0 2 4 8 12 km

FIGURE 3.1  
REPORT 5.1  
GENERAL GEOLOGY

The majority of the rainfall is associated with monsoon conditions and occurs in the spring and early summer when thunder storms come in from over the Red Sea and mist envelops the crest of the escarpment. The further east one travels away from the escarpment the lower the rainfall. The amount of rainfall is especially significant for agriculture and for the replenishment of the ground water resources which serve the urban and rural areas.

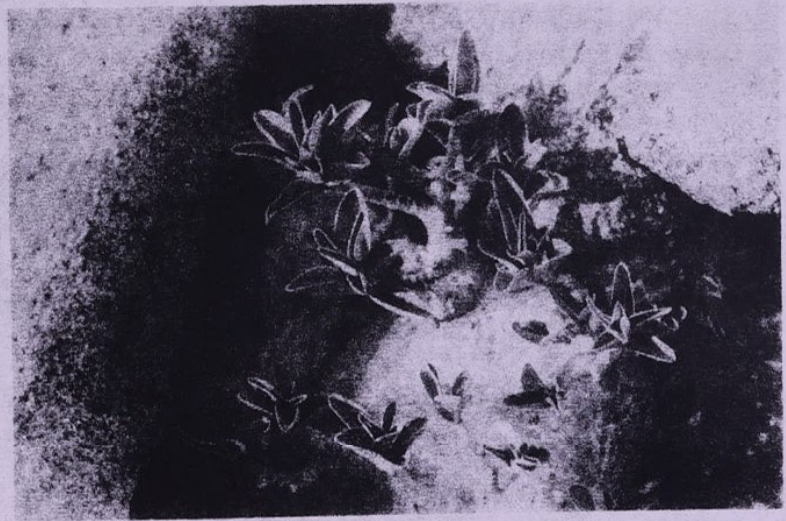
3.2.1 Rainfall

Most of the Metropolitan Area can be classed as arid, that is the annual precipitation by itself is insufficient to permit crop production. Under such circumstances crop production is only possible with irrigation, either from the harnessing of flash floods, securing an annual inundation of flood water or by tapping a constant underground water source. A semi arid climate implies that dry farming is possible, but that the crop variety and yield is constrained by the low and erratic rainfall. Several studies have indicated that the limit of dry farming can be conveniently set at 250mm to 300mm of winter rainfall or 500mm of summer rainfall. Typical rainfall regimes throughout the area are shown in Table 3.1.

Three stations have been taken as representative. Although the records are not all for the same period they permit certain clear differences and trends to be observed. Two of the stations, Abha and Sawdah, are on the escarpment while the third, Tindaha, is located inland beyond Khamis Mushayt.



The tumbled boulders of heavily weathered granite form a dramatic feature in the landscape.



Asir has a wide range of species compared to other regions of the Kingdom. Here a desert rose thrives in a crack in an outcrop of granite, taking advantage of the water that collects and staying the moisture in its swollen

TABLE 3.1  
MEAN MONTHLY RAINFALL 1386-1400h (1966-1980)

Rain gauge station	Mean monthly rainfall (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Abha	26	30	53	60	46	14	46	44	6	20	18	8
Sawdah	29	38	54	79	94	23	51	72	25	15	36	18
Tindaha	7	5	29	31	38	6	19	14	3	11	13	5

Source: Hydrology Division, Department of Water Resources Development

The rainfall at the escarpment is more pronounced, as would be expected, but the pattern of rainfall between the stations is also different. Inland at Tindaha there is one pronounced rainy season with over three-quarters of the total rainfall occurring in the four months February through to May. On the escarpment these four months account for only half the rainfall with an additional less pronounced peak in the summer. It is also apparent how the higher the annual rainfall the greater the annual variation around the mean. Table 3.2 shows that the 95% confidence interval for Abha is + 272.0 mm which is significantly higher than the similar confidence interval for Tindaha, + 120 mm. The 95% confidence interval is the variation around the mean that can be expected with 95% certainty and is equal to 1.96 x the standard deviation.

TABLE 3.2  
ANNUAL RAINFALL VARIATION 1386-1400h (1966-1980)

Annual rainfall mm	Number of recorded occurrences		
	Abha	Sawdah	Tindaha
-200	1	-	9
2 - 300	2	-1	5
3 - 400	7	3	1
4 - 500	3	-	-
5 - 600	1	4	-
6 - 700	1	5	-
700-	-	1	-

Rainfall (mm)	Abha (1966-80)	Sawdah (1966-80)	Tindaha (1966-80)
Mean annual rainfall	370 (402)	536	180
Max. annual rainfall	611	745	325
Min. annual rainfall	143	254	67
95% confidence limits	+ 272	+ 281	+ 120
Expected rainfall (95% confidence)	101 647	265 828	81 321

Source: Department of Water Resources Development, Hydrology Division, Hydrological Publications, Riyadh, 1966-1975. SPS

Because there is less evaporation in the winter, for a given annual precipitation a regime of winter rainfall is more effective than one of summer rainfall. If one makes allow-

(May-September) the comparative rainfall figures would be 300mm for Abha and 124mm for Tindaha. One would therefore expect the limit for rainfed cereal cultivation to be at or near Abha.

### 3.2.2 Temperature, Humidity and Insulation

An illustration of the mean monthly temperatures and associated relative humidity values is provided in Table 3.3. In order to gauge the significance of these figures it is necessary to be able to compare the combined effect of relative humidity and temperatures, since a low relative humidity makes high temperatures more bearable. Experiments have shown that for the majority of people the temperature limits for comfortable living conditions are 22°C to 29°C at a relative humidity of 20% to 50%. In Abha the mean monthly humidity varies from 42% to 65% and fortunately the frequent breezes provide welcome relief.

The combined effect of relative humidity, temperature and air movement can be expressed in one index, the effective temperature or ET, which can be used to help indicate the feeling of warmth or coldness. The most comfortable living conditions are associated with an ET of from 20-26°C ET, and an acceptable limit to coldness can be set at 16°C ET.

Mean monthly maximum and minimum temperatures have been plotted for Abha in Figure 3.2, together with the associated effective temperature. This shows that the temperature never becomes unbearably hot and that for only four months in the year is it decidedly cool. The temperature effect induced by the relief is very noticeable in comparison with other towns in Saudi Arabia such as Riyadh. But whereas the effective temperature in Abha in winter is some 7°ET cooler than that of the central

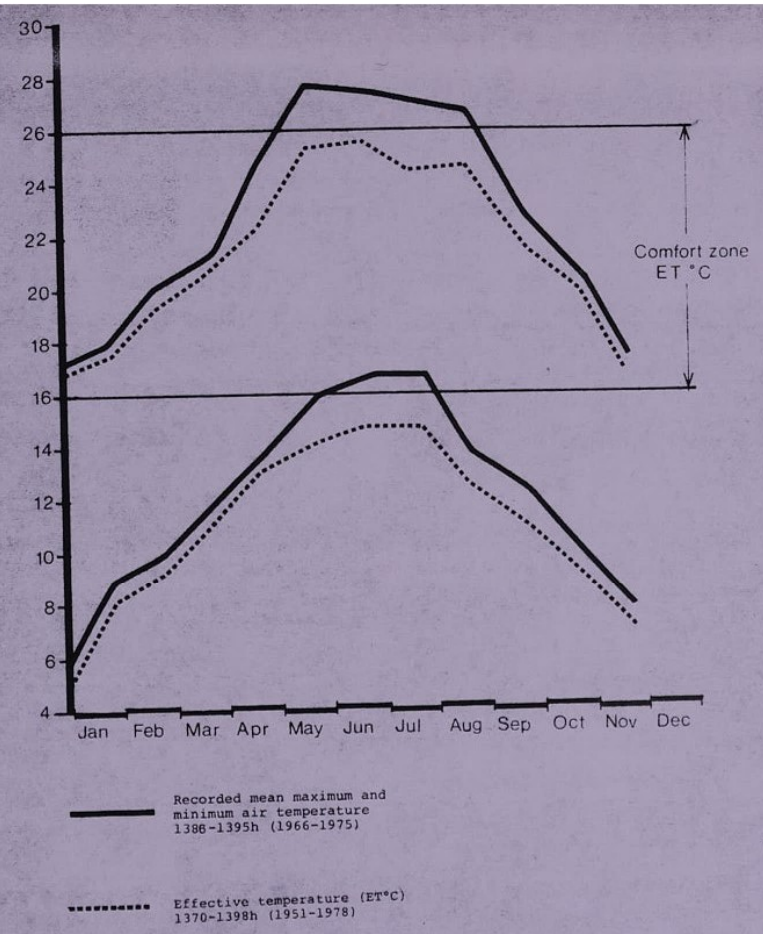


FIGURE 3.2  
REPORT 5.1  
RECORDED AIR TEMPERATURE AND CORRESPONDING EFFECTIVE TEMPERATURE

region, the effect is not so marked in summer because of the higher relative humidity in Abha. In summer the difference in maximum mean monthly temperature is 14°C, yet the effective temperature difference is only 5°ET.

The large number of days when clouds are gathering around the mountain peaks effectively lowers the maximum values of pan-evaporation and other radiation in comparison with other areas of Saudi Arabia. Figure 3.3 illustrates the variation in monthly mean values for pan-evaporation, solar radiation (insolation), and wind speed. The prevailing wind direction is from the south-west.

TABLE 3.3  
MONTHLY TEMPERATURES AND RELATIVE HUMIDITY, ABHA 1386-95h  
(1966-75)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly mean °C	13.1	13.5	14.6	15.5	19.6	21.1	21.1	21.1	20.2	17.2	15.3	13.1
Mean relative humidity %	60	65	60	60	50	42	47	53	48	50	56	58
Max. monthly mean °C	16.5	17.5	20.9	21.0	24.5	27.8	27.6	26.0	26.8	23.0	20.5	17.5
Max. monthly mean relative humidity %	80	90	85	80	73	67	72	78	75	76	86	91
Min. monthly mean °C	5.5	8.5	9.8	11.7	13.6	16.0	16.7	16.8	13.8	12.2	10.0	8.0
Min. monthly mean relative humidity %	37	40	37	37	21	22	25	24	21	20	38	41

Source: Department of Water Resources Development "op cit".

1386-1395h  
(1966-1975)

1386-1395h  
(1966-1975)

1386-1395h  
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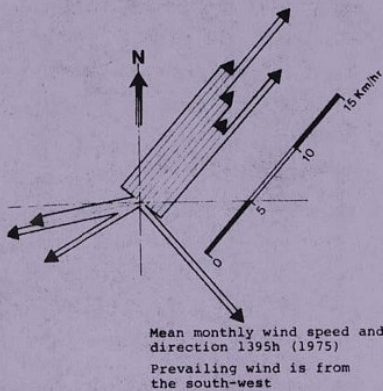
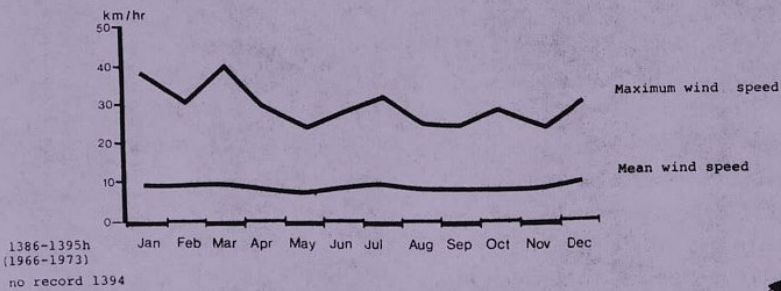
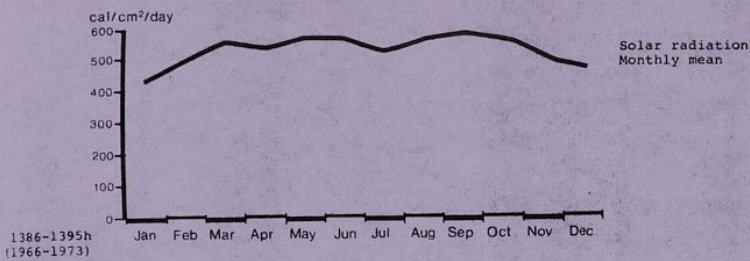
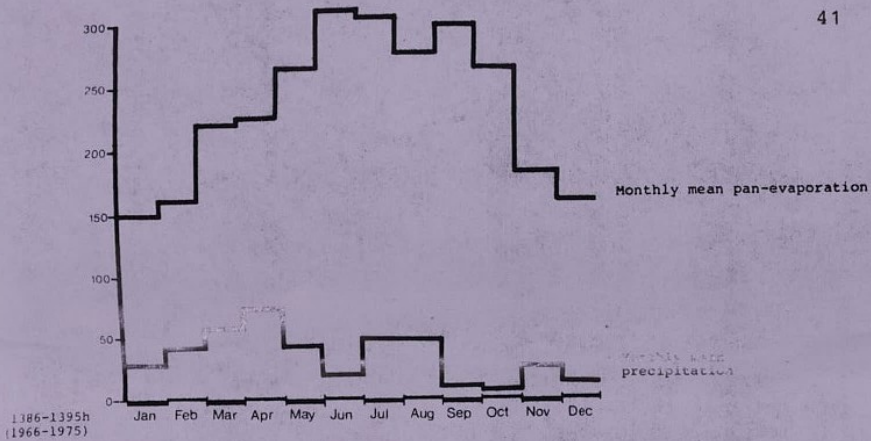


FIGURE 3.3  
REPORT 5.1  
PAN-EVAPORATION  
SOLAR RADIATION  
AND WIND SPEED ABHA



42 3.3 SOILS AND NATURAL VEGETATION

The soils in the Metropolitan Area are extremely varied. Usually they are of a coarse gravelly nature mixed with larger rock fragments, as on the hills and mountain slopes. Fine textured soils, useful for agriculture, are found in the wadis and on the plains in the north and east, and in association with the schist bedrock of the mountain ranges around Abha.

No detailed soil survey or land classification has been attempted, although a general survey for the whole of the Southern Region was carried out by Italconsult in 1969. This survey included only one trial pit in the metropolitan area, but the survey suggests that the soils are generally poor in phosphorus and often also in potassium where the mineral clay content is low.<sup>(1)</sup> Due to rapid decomposition of organic matter the humus content of the soils is low.

The variety and balance of plants present in the natural vegetation is basically a response to the prevailing climatic and soil conditions, although there can be no doubt that human interference can effect substantial modifications. This is true in the Metropolitan Area where woody plants and dwarf shrubs are collected as firewood, and where over-grazing has resulted in the decline of certain species.

Recent studies<sup>(2)</sup> on the distribution of species have shown how limited the variety of species is in Saudi Arabia compared to more temperate climates. The relatively great topographical and climatic variations found within the Southern Region though, means that it has an unusually wide variety of species compared to the country as a whole.

(1) "Water and Agricultural Development Survey for Areas II and III Final Report, Summary" Italconsult 1969.

43 The Metropolitan Area displays three distinctive plant zones. On the upper slopes of the escarpment there are the exceptionally significant natural stands of Juniperus procera forest. This extends from an elevation of 2,500-3,000 m and is the only substantial area of forest in the Kingdom. Along a narrow band following the crest of the escarpment the forest undergrowth flora is very rich. The Juniperus tree is used for firewood. In the mountain wadis which are not used for crop cultivation Acacia and Tamarix are common.

The mountain flora is characterised by low bushy vegetation of Senecio odoros, Rumex sp., Echinops spinosus and Lavendular dentata. The herbaceous vegetation is comparatively rich and includes some perennial grasses of high grazing value, such as Cenchrus ciliaris, Themeda triandra and Cynodon dactylon. These, together with the low productive Eragrostis papposa and Eragrostis barrelieri and the tough and unpalatable Pennisetum setaceum, are the most common grasses on the better sites. On dry and rocky ground Hyparrhenia hirta, a grass of medium grazing value, is the predominant species. No herbaceous leguminous plants have been found in the sward.

The further one descends towards the east the more noticeable is the adaptation of the plants to dry arid conditions. In the hilly plateau zone the dominant tree is the Acacia. It dominates the plant community in the wadis and depressions where there are fine soil deposits capable of trapping the surface water running off the slopes of the surrounding hills and mountains. In this zone Cenchrus ciliaris and Cynodon dactylon have sometimes developed dense stands.

Away from the wadis and depressions in the hilly plateau zone the soils are coarse textured with a rocky surface. Various Aristida sp. are the predominating grasses on dry

and rocky slopes with shallow soil. These grasses are usually grazed when young but are not palatable at the late flowering and seeding stages. In more favourable sites with fine textured and deeper soils the palatable Cenchrus ciliaris is common.

## CHAPTER 4

THE SOCIO-ECONOMIC SURVEY

## 4.1 OBJECTIVES

It is specified in the contract that a socio-economic survey should be carried out to help obtain information that would be relevant to the preparation of a Master Directive Plan and the evaluation of the existing Master Plan. A minimum of 5% of the households in each of the "social and administrative" divisions proposed for the area in the Master Directive Plan were to be interviewed, and information was to be obtained on demographic characteristics, housing provision, educational attainment, the availability of facilities, income and expenditure and occupation. A survey to cover these requirements was undertaken during Shaban 1398h (1978). It covered the whole of the Metropolitan Area, subdivided into rural zones and towns.

A number of other surveys were carried out besides the socio-economic survey because of the general lack of up to date information in many fields. The other surveys are described in Chapter 5 as well as when their information is made use of in the other volumes of this Report. The socio-economic survey, though, was by far the most extensive and elaborate of the surveys, and an explanation of its scope and design is therefore given separately here. A detailed presentation of the results appears in Volume 2 (demographic characteristics, occupation and household income and expenditure), and Volume 3 (housing provision and provision for public facilities and utilities)

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## 4.2 SCOPE OF THE SURVEY

The purpose of using a sample survey rather than a full census was to obtain satisfactory information at reasonable cost. In consequence it must be remembered that information is not available for areas smaller than the subdivisions or strata used in preparing the sample, and that the findings are only an approximation of the true values which would be obtained from a census. As long as the sample is known to be representative of the whole population an estimate can be prepared of how close the approximation is to the real value. For the calculation of the total population in the Metropolitan Area the value given by the survey has been estimated to be within  $\pm 11\%$  of the true value with 95% confidence. For the smaller areas though, where only a few households were interviewed, the margin of sampling error is much larger, ranging from  $\pm 20\%$  to  $\pm 57\%$ . The accuracy in these cases could have been improved by subdividing villages according to their size and taking a more complete sample of the larger villages, but this would have increased the number of interviews required. The accuracy of the sample increases in direct proportion to the square root of the number of interviews in the sample. Therefore, to reduce the sampling error by half requires the sample to increase in size by a factor of four. It is probable that the number of interviews in the rural subdivisions would have had to be increased by a factor of five to arrive at the same order of accuracy as the estimate for Abha and Khamis Mushayt, and this additional effort could not be justified in terms of the possible value of the results.

The rural strata used were agreed with the Ministry of Municipal and Rural Affairs prior to the commencement of the survey, and are shown in Figure 4.1. Some of

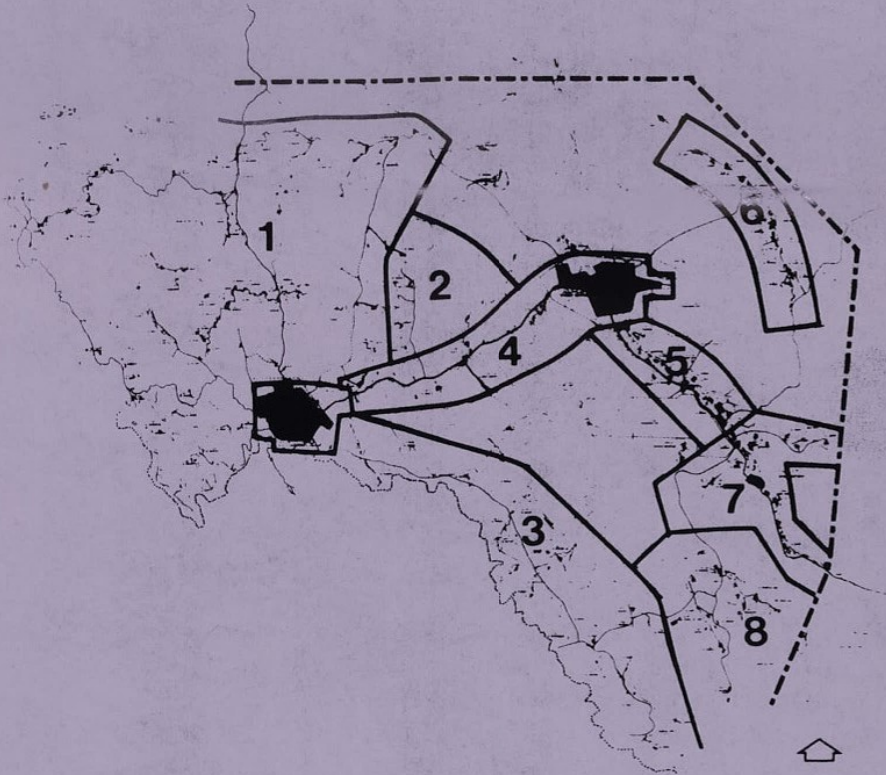
1 Abha no

2 Mahala

3 Escarp

4 Main r

FIGURE  
REPORT  
RURAL  
STRATA



- |          |                                 |
|----------|---------------------------------|
| <b>1</b> | Abha north and north-west       |
| <b>2</b> | Mahala area                     |
| <b>3</b> | Escarpment south-east of Abha   |
| <b>4</b> | Main road Khamis Mushayt - Abha |

- |          |                               |
|----------|-------------------------------|
| <b>5</b> | Main road Khamis/Ahad Rafidah |
| <b>6</b> | Tindaha                       |
| <b>7</b> | Ahad Rafidah rural            |
| <b>8</b> | Wadi Ain                      |

**FIGURE 4.1**  
**REPORT 5.1**  
**RURAL SURVEY**  
**STRATA**

0 2 4 8 12 km

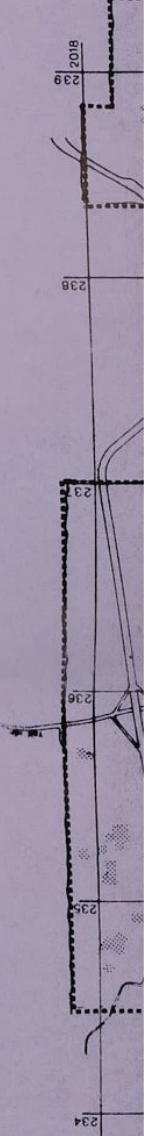
these were later amalgamated, (Table 4.1) to form more convenient planning zones. It was not possible to determine the boundaries used in the 1394h(1974) census of Abha and Khamis Mushayt, and it was not possible, therefore, to compare the growth of these same areas between 1394h(1974) and 1398h(1978). The boundaries of Abha and Khamis Mushayt that were agreed on for the present survey are shown in Figures 4.2 and 4.3 and include the built-up areas of each town.

#### 4.3 SAMPLE SELECTION

The method of obtaining the sample was discussed in detail with representatives from the Ministry of Municipal and Rural Affairs and agreed with them prior to the survey being undertaken.

In order to ensure that the sample was representative of the whole population, each household interviewed had to be selected at random from the population, thus ensuring that every household had an equal chance of being chosen. The usual method used to achieve this is to select households at fixed intervals from an alphabetical register of households. In this case, however, no register existed and to have to interview a random selection of respondents scattered over the whole of the Metropolitan Area would have been a lengthy and expensive procedure.

The survey was designed as a two stage stratified sample. This is a type of random sample in which the overall population is first classified into sub-groups or strata according to a certain principle, and then a random sample is taken from within each stratum. In the present case the random sampling within each stratum has been simplified by first selecting population clusters within



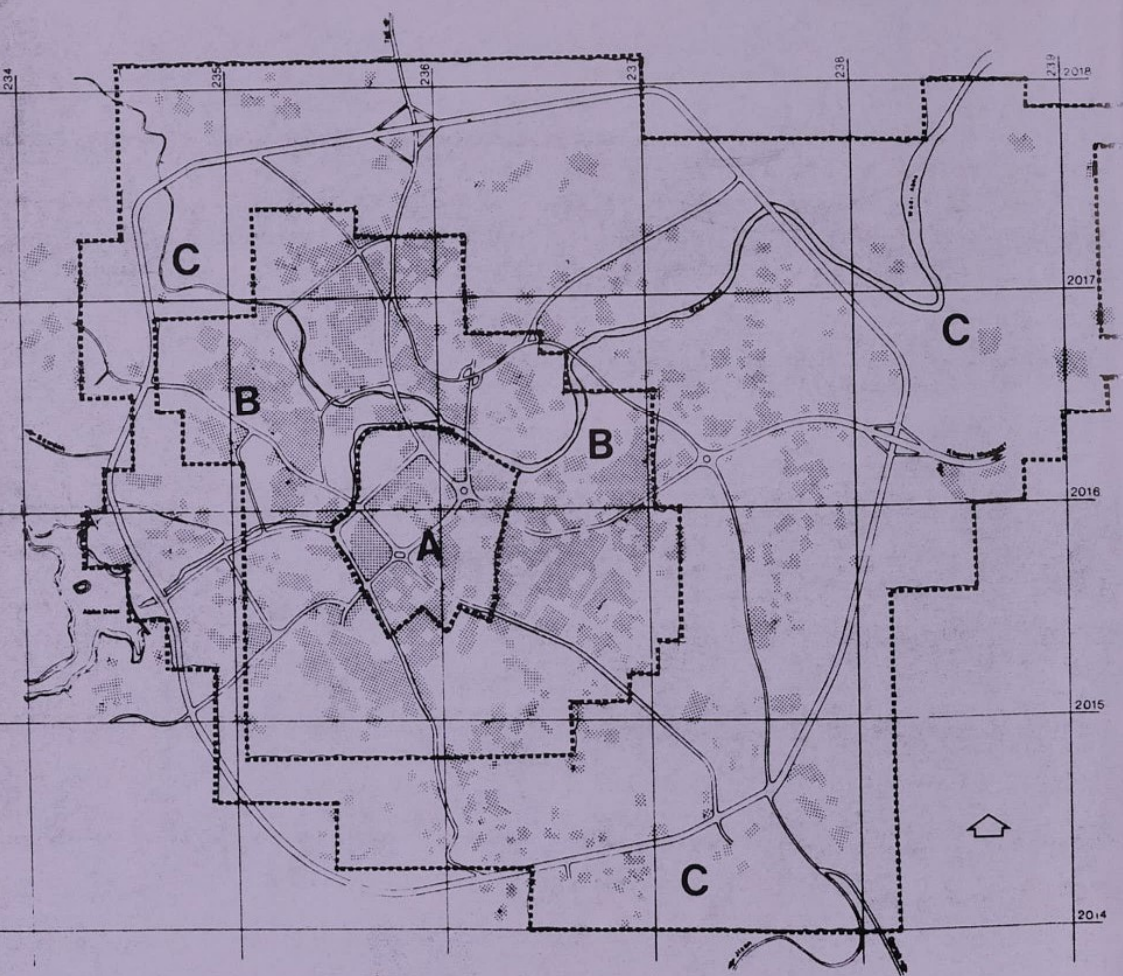
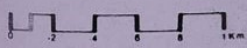


FIGURE 4.2  
REPORT 5.1

BOUNDARY FOR  
HOUSEHOLD SURVEY,  
ABHA, 1398h (1978)

- A Central District
- B Inner City
- C Outer City

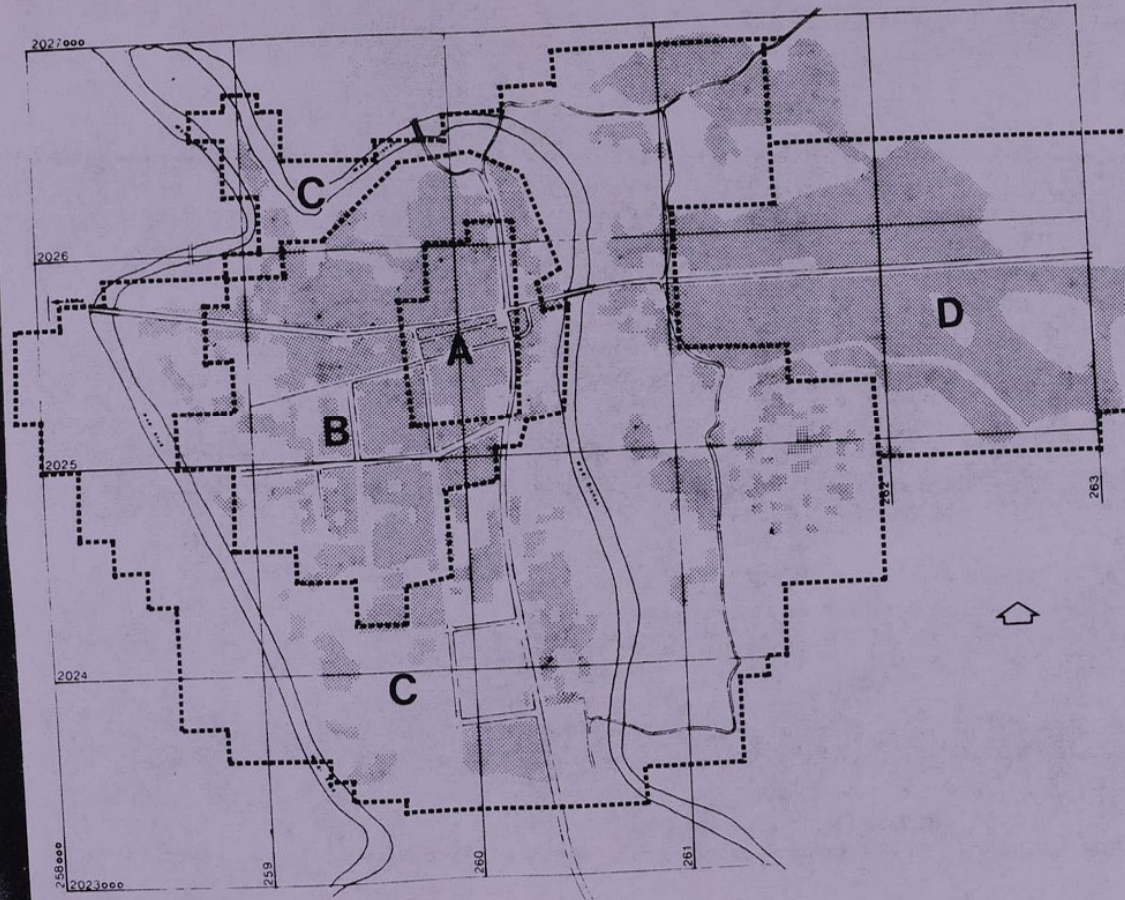
In the presentation of results  
B and C have been combined into  
one zone - the outer zone



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CONS. SCAN PLAN SWECO ARCH CENTRE  
PROJECT 206

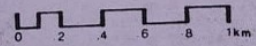
FIGURE 4.3  
REPORT 5.1

BOUNDARY FOR  
HOUSEHOLD SURVEY,  
KHAMIS MUSHAYT  
1398h (1978)



- A Central District
- B Inner City
- C Outer City
- D Zinc City

In the presentation of results  
B and C have been combined into  
one zone, - the outer zone



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the total population and restricting the selection of the random sample to these population clusters. This greatly simplifies the labour involved in obtaining a representative sample.

The purpose of stratification was to obtain an idea of the population distribution and to improve the representativeness and hence accuracy of the final sample. Unadjusted clustering reduces the accuracy in comparison with a simple random sample.

In the rural areas the population clusters were the villages, and a final sample of households was drawn from among a selection of these villages. In the urban areas the population clusters were regular subdivisions of the urban area, and the final household sample was drawn from among a selection of these population clusters.

The validity of the rural sampling depended on an accurate and up to date record being available of all the villages, otherwise the sample would be biased and subject to unknown error. A list of villages was obtained from the Italconsult "Feeder Road Master Plan" with maps at a scale of 1:100,000. It was possible to verify the location of the villages over that part of the Metropolitan Area covered by a photo-mosaic. In some cases there were clusters of villages located adjacent to each other and these were treated as a single village if they had a common name. In order to achieve a 5% sample, 20% of the villages were selected at random and every fourth household within them interviewed. An exception was made at Tindaha where 8% of the households were sampled, and in the Abha Rural area (north and north west Abha) where, because of the number of villages involved, it was agreed to sample 10% of the villages and every second household within each selected village. A list of the number of

villages selected and households interviewed appears in Table 4.1. Because the frame for organising the sample only consisted of villages the survey excluded work camps.

In the urban areas the frame used to select the sample consisted of a grid of blocks of constant size. In Abha the grid was drawn on 1:1,000 scale maps prepared from an aerial survey of 1396h(1976). In Khamis Mushayt a 1396h (1976) photo-mosaic was used. To obtain a 5% sample the blocks were numbered consecutively and 20% of the blocks were selected at random, and every fourth household in the selected blocks interviewed. This method did not require every existing building to be shown on the map or photo-mosaic, only that the selected blocks should be identifiable on the ground and that the frame include the whole of the built-up and semi built-up area.

In the same way that the rural area was stratified, so were the urban areas, except for Ahad Rafidah, subdivided into central, inner and outer areas. In the case of Khamis Mushayt a separate subdivision was made for Zinc City. Because of the smaller size of the central and inner areas, the size of the block was reduced to obtain a representative sample. A block size of 100m x 100m was adopted in the central area, 100m x 200m in the inner area and 200m x 200m in the outer area. In the case of Zinc City only 10% of the blocks were selected because of the problems involved in defining the blocks on the ground. Once the blocks had been selected every other household was interviewed, Table 4.2.

TABLE 4.1  
RURAL SAMPLE 1398h(1978)

A	B	C	D	E	F	G
Rural Stratum	Total number of villages	Number of villages selected	Number of households in C	Estimated number of households in B $E = \frac{B}{C} \times D$	Number of Households selected for interview	$\frac{F}{E} \%$
1 Abha north +north west	177	17	259	2,697	140	5.2%
2 Mahala area	15	3	25	125	7	5.6%
3 Escarpment south of Abha	46	9	172	879	42	4.8%
4 Khamis-Abha main road	8	2	54	216	14	6.5%
5 Khamis-Ahad Rafidah road	11	2	192	1,056	47	4.5%
6 Tindaha	17	6	338	958	80	8.4%
7 Ahad Rafidah Rural	17	2	92	782	21	2.7%
8 Ahad Rafidah South(Wadi Ayn)	19	4	127	603	31	5.1%
Total	310	45	1,259	7,316	382	5.2%

Note: For planning purposes strata 1 and 2 were combined to form Abha rural; strata 4 and 5 were combined to form Khamis rural; and strata 7 and 8 were combined to form Ahad Rafidah rural.

Source: SPS

TABLE 4.2  
URBAN SAMPLE 1398h(1978)

A	B	C	D	E	F	G
Urban Area	Total number of blocks	Number of blocks selected	Number of Households in C	Estimated number of households in B	Number of households interviewed	
Abha central	54	4	58	783	15	2.0%
inner	178	39	897	4,094	226	5.5%
outer	213	34	281	1,760	71	4.0%
Abha town						4.4%
Khamis central	25	5	188	940	42	4.5%
inner inner	120	24	480	2,400	112	4.7%
outer	85	19	323	1,445	93	6.4%
Zinc City	260	26	421	4,210	203	4.8%
Ahad Rafidah	63	7	65	585	17	2.9%
Total	998	158	2,713	16,217	779	4.8%

Note: For planning purposes the inner and outer areas were combined into one zone and known as the outer zone.

Source: SPS

The boundaries for the different areas are shown in Figures 4.2 and 4.3. This sample frame was also used to conduct a transportation survey which is described in more detail in Volume 4 and Chapter 5 of this volume.

#### 4.4 FORMAT OF QUESTIONNAIRE

The questionnaire, which is set out in Appendix 1, consisted of a general section applicable to all households, and a supplementary rural section used only in rural areas. The questionnaire was agreed in detail in its Arabic version with the Ministry of Municipal and Rural Affairs prior to the survey.

#### 4.5 FIELD PROCEDURES

Twenty five Saudi interviewers were selected for the survey, mainly teachers, with some students and municipal employees. These interviewers received a four day training including practice under supervision in private homes.

A pilot survey was undertaken covering about 35 interviews to test the structure and clarity of the questions. The full survey was then carried out in Shaban 1398 (June 1978).

In undertaking the survey, interviewers were accompanied in the field by supervisors who were also responsible for the selection of the respondents' homes. All questionnaires were checked on a day to day basis so that repeat interviews could be undertaken where necessary. In addition a 5% sample of completed questionnaires was randomly selected from each interviewer's work and checked by repeating all or part of the interview.

Replacement procedures were carried out as agreed prior to launching the survey, using the technique of replacement sampling following successive call back attempts. A minimum of three call backs were made before proceeding to substitution. Non-response was calculated at approximately 2% for urban areas and 1% for rural areas, which signifies that the survey achieved a very high response rate.

#### 4.6 STATISTICAL ANALYSIS

Assuming that the sample is chosen in a way that makes it representative of the population from which the sample is being taken one can relate:

- (a) the variance in the sample to the variance in the estimate for the total population.
- (b) the probability of the degree to which the mean of the sample distribution differs from the mean of the population, to the variance in the population, assuming a large sample.

The variance is a number which measures the degree of dispersion of a set of numbers about their mean.

It can be shown that within each stratum the variance in the estimated total population is related to the variance in the household size within each sampled cluster, and the variance in the estimated population of all the sampled clusters. A similar principle holds true for the variance in the average household size within the stratum.

In combining the results for all strata it can be shown that the variance in the estimated household size for the sum of all strata can be related to the variance in the estimated household size of all the sampled clusters and the variance in the estimated average household size for each stratum. The variance in the total population for the sum of all strata is equal to the sum of the estimated population variance for each stratum.

It can be shown that if samples are repeatedly taken from a population then the distribution of the mean of the samples will approximate very closely to a normal distribution having the same mean and variance as the sampling distribution of the mean of the samples. The quality of the approximation improves as the size of the sample increases. Specifying the mean and variance completely determines a particular normal distribution. Using this one can express the probability that the sample mean lies within a certain number of units of "standard deviation" away from the theoretical mean of a large number of samples. This theoretical mean is the actual mean of the total population. The standard deviation is defined as the square root of the variance. Making use of this property the standard deviation of the survey results has been used to calculate the range within which the true population can be expected to lie with a known certainty. For example, with 95% certainty the true population mean is known to lie within  $\pm 1.96$  standard deviation units away from the sample mean.

4.6.1 Variance of Population and Household Size Within a Stratum

Within each sampled cluster the following definitions apply:

- $\bar{y}_i$  is the average household size for the  $i^{th}$  cluster
- $S_i^2$  is the variance in household size for the  $i^{th}$  cluster
- $y_{ij}$  is the size of household  $j$  in cluster  $i$
- $m_i$  is the number of households interviewed in cluster  $i$
- $M_i$  is the total number of households in cluster  $i$

then

$$\bar{y}_i = \frac{\sum_{j=1}^{m_i} y_{ij}}{m_i}$$

and  $S_i^2$  is defined as

$$S_i^2 = \frac{\sum_{j=1}^{m_i} (\bar{y}_i - y_{ij})^2}{m_i - 1}$$

Within each stratum the following definitions apply:

- $S_r^2$  is the variance in household size for the sample of  $n$  clusters
- $\hat{\mu}_r$  is the average household size for the stratum taken from the sample of  $n$  clusters
- $n$  is the number of clusters in the sample
- $N$  is the total number of clusters in the stratum
- $\bar{M}$  is the average number of households per cluster
- $t$  is the total population within the stratum
- $S_b^2$  is the variance in the population among the

then

$$\hat{\mu}_r = \frac{\sum_{i=1}^n M_i \bar{y}_i}{\bar{M}n}$$

$$\bar{M} = \frac{\sum_{i=1}^n M_i}{n}$$

$$t = N \frac{\sum_{i=1}^n M_i}{n}$$

and  $S_r^2$  is defined as

$$S_r^2 = \frac{M_i (\bar{y}_i - \hat{\mu}_r)^2}{n-1}$$

and  $S_b^2$  is defined as

$$S_b^2 = \frac{(M_i y_{ij} - \bar{M} \hat{\mu}_r)^2}{n-1}$$

it can be shown that

$$(a) V(\hat{\mu}_r) = \left[ \frac{(N-n)}{N} \frac{1}{n\bar{M}^2} S_r^2 \right] + \frac{1}{n\bar{M}} \sum_{i=1}^n \frac{(M_i - m_i)}{M_i} \frac{S_i^2}{m_i} M_i^2$$

where  $V(\hat{\mu}_r)$  is the variance in  $\hat{\mu}_r$

$$(b) V(t) = \left[ \frac{(N-n)}{N} \frac{N^2}{n} S_b^2 \right] + \left[ \frac{N}{n} \sum_{i=1}^n \frac{M_i^2 (M_i - m_i) S_i^2}{M_i m_i} \right]$$

where  $V(t)$  is the variance in  $t$

and by definition the standard deviation of  $\hat{\mu}_r$

$$\text{or } \sigma_{\hat{\mu}_r} = \sqrt{V(\hat{\mu}_r)}$$

$$\text{and } \sigma_t = \sqrt{V(t)}$$

#### 4.6.2 Variance of Population and Household Size for all Strata Combined

For the set of all strata the following definitions apply:

T is the estimated population of all strata combined

L is the total number of strata

Y is the estimate of the total number of households within the set of L strata

$t_h$  is the estimated population of stratum h

$N_h$  is the total number of clusters within stratum h

$Y_h$  is the estimate of the number of households within stratum h

$\bar{y}_{hi}$  is the average household size for cluster i within stratum h

$n_h$  is the number of selected clusters in stratum h

$M_{hi}$  is the total number of households in cluster i within stratum h

$\bar{M}_h$  is the average number of households within each cluster in stratum h

$m_{hi}$  is the total number of selected households in cluster i within stratum h

$\hat{\mu}_h$  is the average household size for stratum h

$\hat{\mu}_R$  is the estimated average household size for all L strata together

$V_{rel}(\hat{\mu}_R)$  is the relative variance for  $\hat{\mu}_R$

then

$$T = \sum_{h=1}^L t_h$$

$$V(T) = \sum_{h=1}^L v(t_h)$$

$$Y_h = \frac{N_h}{n_h} \sum_{i=1}^{n_h} M_{hi}$$

$$Y = \sum_{h=1}^L Y_h$$

$$\hat{\mu}_R = \frac{T}{Y}$$

$$v(\hat{\mu}_R) = \mu_R^2 v_{rel}(\hat{\mu}_R)$$

$$\text{and } \sigma_{\hat{\mu}_R} = \sqrt{v(\hat{\mu}_R)}$$

It can be shown that

$$v_{rel}(\hat{\mu}_R) = \frac{1}{T^2} \sum_{h=1}^L \frac{N_h}{n_h} \left[ (N_h - n_h) S_{h1}^2 + \sum_{i=1}^{n_h} \frac{M_{hi}}{m_{hi}} (M_{hi} - m_{hi}) S_{h2}^2 \right]$$

$$\text{where } S_{h1}^2 = \frac{1}{n_h - 1} \left[ \sum_{i=1}^{n_h} (M_{hi} \bar{y}_{hi} - \hat{\mu}_h)^2 + \hat{\mu}_R^2 \sum_{i=1}^{n_h} (M_{hi} - \bar{M}_h)^2 - 2 \hat{\mu}_R \sum_{i=1}^{n_h} (M_{hi} \bar{y}_{hi} - \hat{\mu}_h) (M_{hi} - \bar{M}_h) \right]$$

$$\text{and } S_{h2}^2 = \sum_{i=1}^{m_{hi}} \frac{(y_{hij} - \bar{y}_{hi})^2}{M_{hi} - 1}$$

#### 4.6.3 Summary of Results

Using the expressions for the variance in the population and household by individual strata and in combination, results can be obtained for the variation in value around the mean that can be expected with 95% confidence. These limits correspond to  $\pm 1.96$  standard deviations. The results for individual strata are shown in Table 4.3.

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The table shows that the variation around the mean value for the total population is 11% (95% confidence interval).

In the sample areas the variation is greater. In those with a small population a higher value is obtained than in those with a higher population. This is to be expected when using a 5% sample for all areas.

The variation is also dependent on the homogeneity within the areas. If, for instance, the variation in household size is large it contributes to increase the various in the population estimate.

The result is that the variation in the estimated population is very large. This shows clearly that the survey cannot be used for estimating population in small areas. Thus the result has only been used for the town area of Abha, Khamis Mushayt and the rural areas as a whole.

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TABLE 4.3  
SUMMARY OF HOUSEHOLD SIZE, POPULATION AND CONFIDENCE LIMITS

A	B	C	D	E	F	G
Sample area or stratum	Mean household size for sample in B	Variance in B	$\sigma_B$	Total population estimate	$6E$	95% confidence limit for E expressed as % variation around the mean
Abha centre	5.194	0.128	0.358	4067	1437	69%
inner	6.199	0.057	0.238	25381	3661	+ 28%
outer	5.919	0.118	0.344	10419	2407	- 45%
Khamis centre	6.012	0.732	0.856	5652	1081	+ 37%
inner	6.550	0.116	0.340	15720	2352	+ 29%
outer	6.477	0.215	0.464	9360	1925	+ 40%
Zinc City	5.802	0.044	0.203	24428	2962	- 24%
Ahad Rafidah	6.923	0.866	0.931	4050	1081	+ 52%
Abha north and north west	7.172	0.119	0.345	19342	2774	- 28%
Mahala	9.120	0.306	0.554	1140	652	+ *
Escarpment south of Abha	6.712	0.263	0.513	5900	769	- 26%
Abha-Khamis main road	7.778	0.189	0.435	1680	655	+ 76%
Khamis-Ahad Rafidah road	7.926	0.970	0.985	8370	1200	- 28%
Tindaha	6.942	0.103	0.321	6649	2192	+ 65%
Ahad Rafidah rural	8.521	0.300	0.547	6663	3290	+ *
Ahad Rafidah south	5.907	0.117	0.341	3563	609	- 34%
Total	6.487	0.246	0.496	152384	8258	+ 11%

Note: \* variation equals or exceeds 100%. Source: SPS

## 5.1 GENERAL

The socio-economic survey was supplemented by three other surveys designed to find out more about the existing built environment and land use. They were a land use survey, a survey on vacancy rates in housing and a survey of selected industrial establishments.

In addition four traffic surveys were carried out, and a special survey was made of water abstraction from all wells in and around the towns during one month. This has proved to be the only method of obtaining information on likely per capita water consumption.

Reliable information was also lacking on the position of new buildings constructed since the last aerial survey in 1397h (1977). To remedy this has required a team of two surveyors and two assistants being permanently assigned to the task of updating base maps since Safar 1399h (January 1979). This work is now substantially complete except for the extensive area of informal zinc housing at Khamis Mushayt which has never had a proper base map to begin with. Figure 5.1 shows the extent of the original air survey in 1397h (1977) and the available map sheets at a scale of 1:10,000 and 1:1,000.

## 5.2 SURVEYS Dhual Qidah 1398h (October 1978)

5.2.1 Land Use Survey

The survey plotted the land use of each building in the towns of Abha, Khamis Mushayt and Ahad Rafidah. The classification of land uses was based on that prepared by the United Nations Physical Planning Project for the



70  
Kingdom. The classification was extended to include details of building quality, judged subjectively, and the number of households occupying a dwelling.

The land use categories used in mapping were:

- Residential
- Commercial
- Manufacturing
- Administrative buildings:
  - Government
  - Local
- Formal open space for recreation
- Public facilities: school, hospital, mosque
- Cemetery
- Agricultural land.

In plotting the land use the data was assembled in coded form on field sheets with each building represented by a unique reference number. It would be possible to relate these index numbers to the mapping grid co-ordinates and in this way store all the information in a data bank for easy retrieval and manipulation.

The information has been made use of in Volume 3, Land Use and Physical Development and is also used in preparing base maps of existing conditions for each Action Area.

#### 5.2.2 Housing Vacancy Survey, Moharram 1398h (December 1978)

In order to realise how much of the housing stock was vacant a special sample survey was made of the housing in Abha and Khamis Mushayt to determine the proportion of dwellings that were unoccupied. The sample varied from 25% of all apartment houses to 11% of all modern

71  
houses. Using the results of the survey and a knowledge of the overall distribution of buildings an average vacancy rate could be determined (Volume 3).

#### 5.2.3 Industrial Establishment Survey, Shawal 1398h (August 1978)

This survey did not attempt a comprehensive coverage of the whole area since its purpose was only to gain an impression of the industrial output and whether there were any marketing problems associated with manufacturing in the Metropolitan Area. A selection of the larger firms within the urban areas were interviewed, and because the scale of development seemed so rapid along the main roads all the establishments along those main roads as well.

The survey along the main roads was repeated a year later to obtain an idea of current growth. Results were prepared showing current growth in employment and number of establishments. The distribution of development by type of activity has also been recorded.

#### 5.2.4 Traffic Surveys

Four sets of traffic surveys were carried out as follows:

- Household Survey, Shaban 1398h (June 1978)
- Cordon and Origin and Destination
- Regular and spot traffic counts
- Parking surveys in Abha and Khamis Mushayt

The Household Survey was organized in conjunction with the Socio-economic Survey but sampled 10% rather than 5% of the population in order to obtain a better idea of trip behaviour in each urban area. The survey provided essential information on vehicle ownership and pattern of trip making. A copy of the questionnaire is included in Appendix 2. The survey and its results are presented in volume 5.

The cordon origin and destination survey was designed to provide information on trip purpose for all vehicles passing the cordon with destination or origin inside the cordon. This information, together with the results of the traffic model for traffic generated entirely within the cordon, could be used to provide a picture of total present and likely future traffic on the roads.

Regular hourly traffic counts were made over a year at two locations. They were supplemented by spot weekly counts on all the major roads. Information on all these weekly counts and their position appears in Volume 4.

The parking surveys were designed to provide information on parking demand in relation to trip purpose and thus derive an existing parking norm for various land uses. The survey was also useful in showing the accumulation of parking over the day and the peak demand by different zones in the centres of Abha and Khamis Mushayt.

#### 5.2.5 Well Inventory, Dhual Hijjah 1398h (November 1978)

With the assistance of the Umda or local spokesman it was possible to locate and survey every well in and around Abha and Khamis Mushayt. Information on the amount of water abstracted and its distribution enabled an estimate to be made of present day per capita consumption. A survey was also made of a restricted area in the countryside in order to form an idea of the order of magnitude of agricultural abstraction and hence to be able to form an idea of the total present water demand within the Metropolitan Area. Industrial demand is at the moment negligible and no special survey was required for this. The survey is presented in Report 5:3, Chapter 9.

#### 5.2.6 Updating of Base Maps, Safar 1399h (January 1979)

This is a continuous task involving three surveyors and their assistants full time. An up to date base map is essential for the preparation of Action Area Plans, and since the total housing stock is growing at the rate of 15% a year an enormous amount of development has occurred since the last aerial survey in 1397h(1977). The task is not made any easier by the fact that no satisfactory method exists for the plotting of new buildings once building permission is granted and development commences.

Updating is required even when no fresh development has taken place because the published maps fail to distinguish between open yards and buildings; in both cases only external walls are indicated and there is no shading to indicate covered areas.

The accuracy of the work has to be sacrificed to a certain extent in the interests of speed, and for example an uncorrected aerial survey would make progress much easier. An uncorrected aerial photograph would be considerably cheaper to obtain than a full aerial survey. A full aerial survey would then only be required every five to seven years. Availability of existing maps is shown in Figure 5.1)

Progress to date is shown in Figures 5.2 and 5.3. As at J'Awal 1400h (April 1980) 19 sheets had been updated in Abha, 11 in Khamis Mushayt and 2 in Ahad Rafidah, all at a scale of 1:1,000. Further revision of the base maps takes place as part of the preparation of survey information for each action area.

As part of the studies for the Master Directive Plan a rapid survey has already been mounted to determine the extent of the built-up areas as at J'Awal 1400h (April 1980).

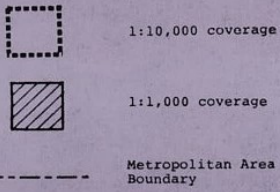
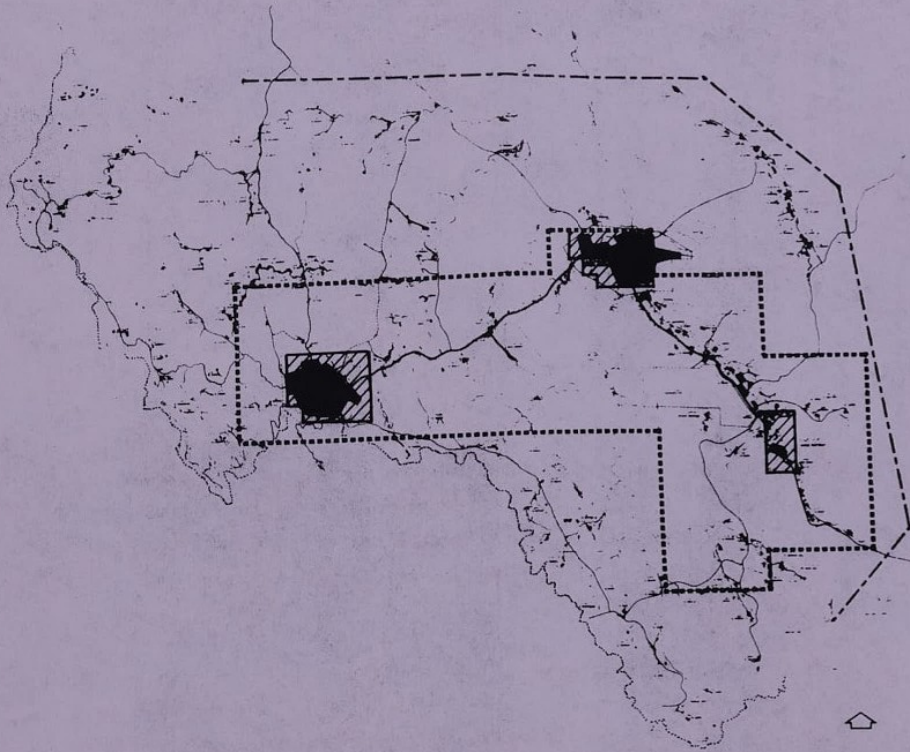
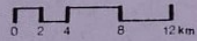


FIGURE 5.1  
REPORT 5.1  
EXISTING  
MAPPED AREAS  
1396h (1976)



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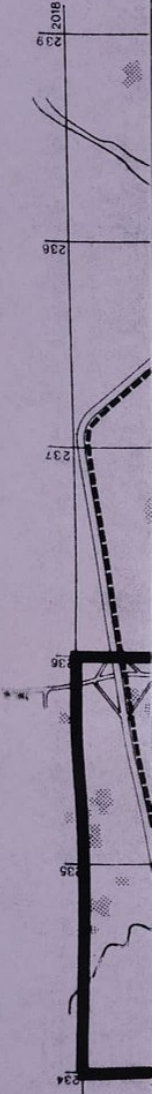


FIGURE 5.2  
REPORT 5.1

UPDATED BASE  
MAPS, ABHA  
1400h (1980)



Extent of updated Base Maps

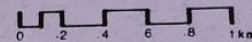


Action Area



Revised base maps for  
Action Area Survey

The relevant updated base  
maps are revised prior to  
each Action Area Survey



PLANNING AND DEVELOPMENT  
DEPARTMENT FOR  
ABHA METROPOLITAN AREA  
CONS. SCAN PLAN SWECO-ARCH CENTRE  
PROJECT 206