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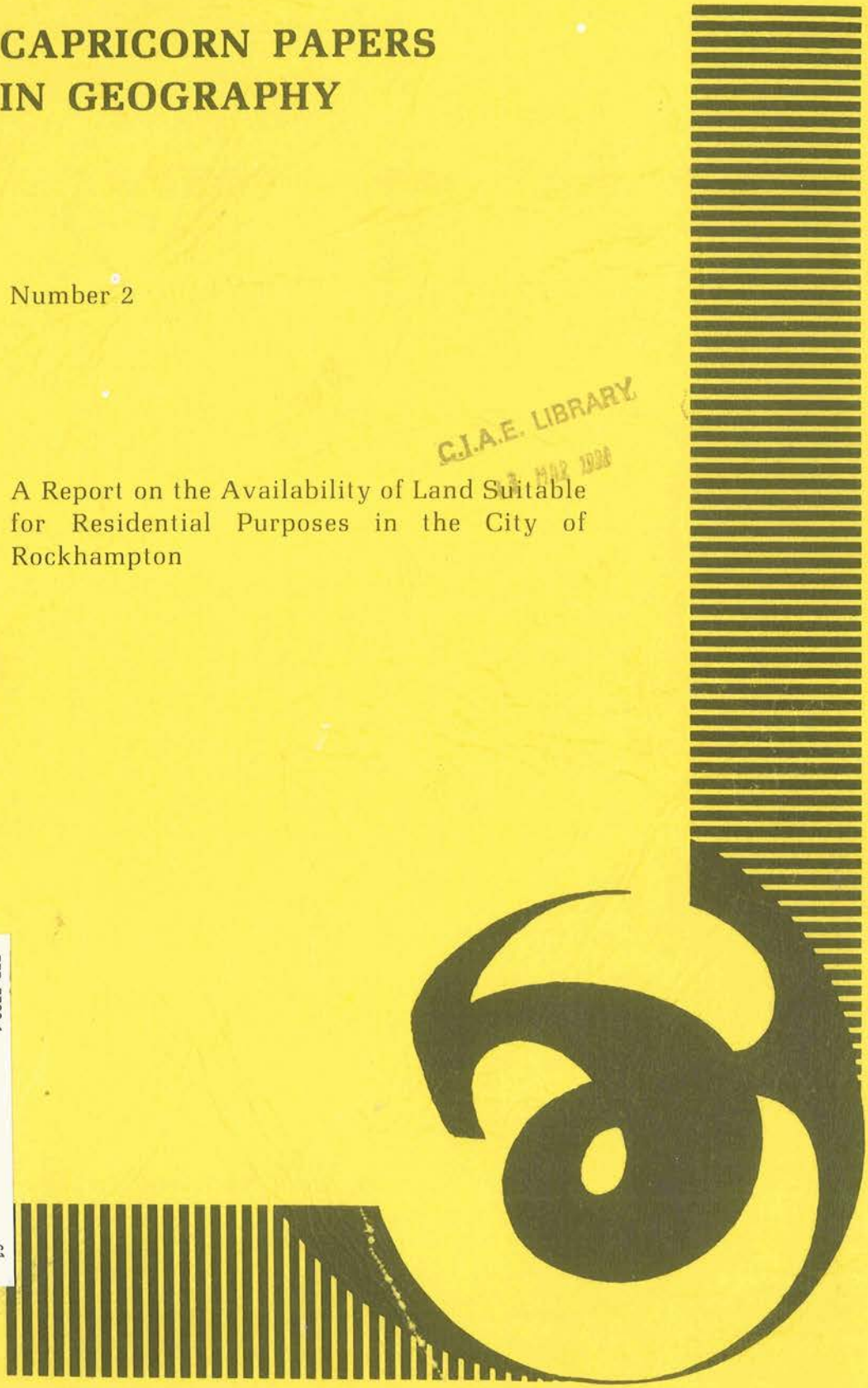
Number 2

A Report on the Availability of Land Suitable for Residential Purposes in the City of Rockhampton



CAPRICORNIA INSTITUTE OF ADVANCED EDUCATION

A REPORT ON THE AVAILABILITY OF LAND FOR RESIDENTIAL PURPOSES IN THE CITY OF ROCKHAMPTON

by

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PREFACE

This is the second in the series Capricorn Papers in Geography which stresses the practical contribution that students can make to solving the problems of the local community.

These papers represent the original work of Geography students at the Capricornia Institute of Advanced Education and their manuscripts have only been edited to correct the most obvious spelling and punctuation mistakes.

The aim of this study was to determine the number of residential allotments that could be created in the Rockhampton Local Government Area. It was recognized that the City of Rockhampton had relatively little land available for future expansion and that an inventory of residential land could benefit those concerned with planning the future growth of the city. It was also felt that local real estate agents and property developers could gain from a detailed study of factors constraining the continued development of the city.

Early chapters discuss the general nature of past residential development in the City and present details of the controls which at present dictate the pattern of residential development.

In this way the report provides the type of information that is of immediate practical value to the local community.

SUMMARY OF RESULTS

This study showed that residential development in Rockhampton is largely determined by local and regional economic fluctuations rather than national or State trends.

There was no direct relationship between the rate of sub division of new allotments and the costruction of new homes. It was clearly difficult for developers to balance the supply of residential allotments to the current demand. Stocks of vacant allotments peaked at the end of 1970 and then rapidly declined in the period up to mid 1976 as more houses were commenced than new allotments sub divided. However, continued sub division after 1976 exceeded commencements so that stocks were quickly replenished. Consequently, there is a distinct prospect of an oversupply of residential allotments emerging in the near future.

At present 68.5% of the 16,100 ha. of the City of Rockhampton is unzoned. Just over half of the zoned area (51%) is allocated to residential uses of which 65.5% is already fully developed. Thus there is 1,691 ha. fully developed, 226 ha. partly developed and 952 ha. undeveloped.

Only 1,177 ha. of land was found to be suitable for future residential purposes. The majority of this (88%) was found North of the Fitzroy River. Five hundred and ten hectares (43.3%) was already zoned 'residential', 128.5 ha. was zoned 'future residential' and the remaining 600 ha. was unzoned at present. Most of this land (70%) was being used for grazing.

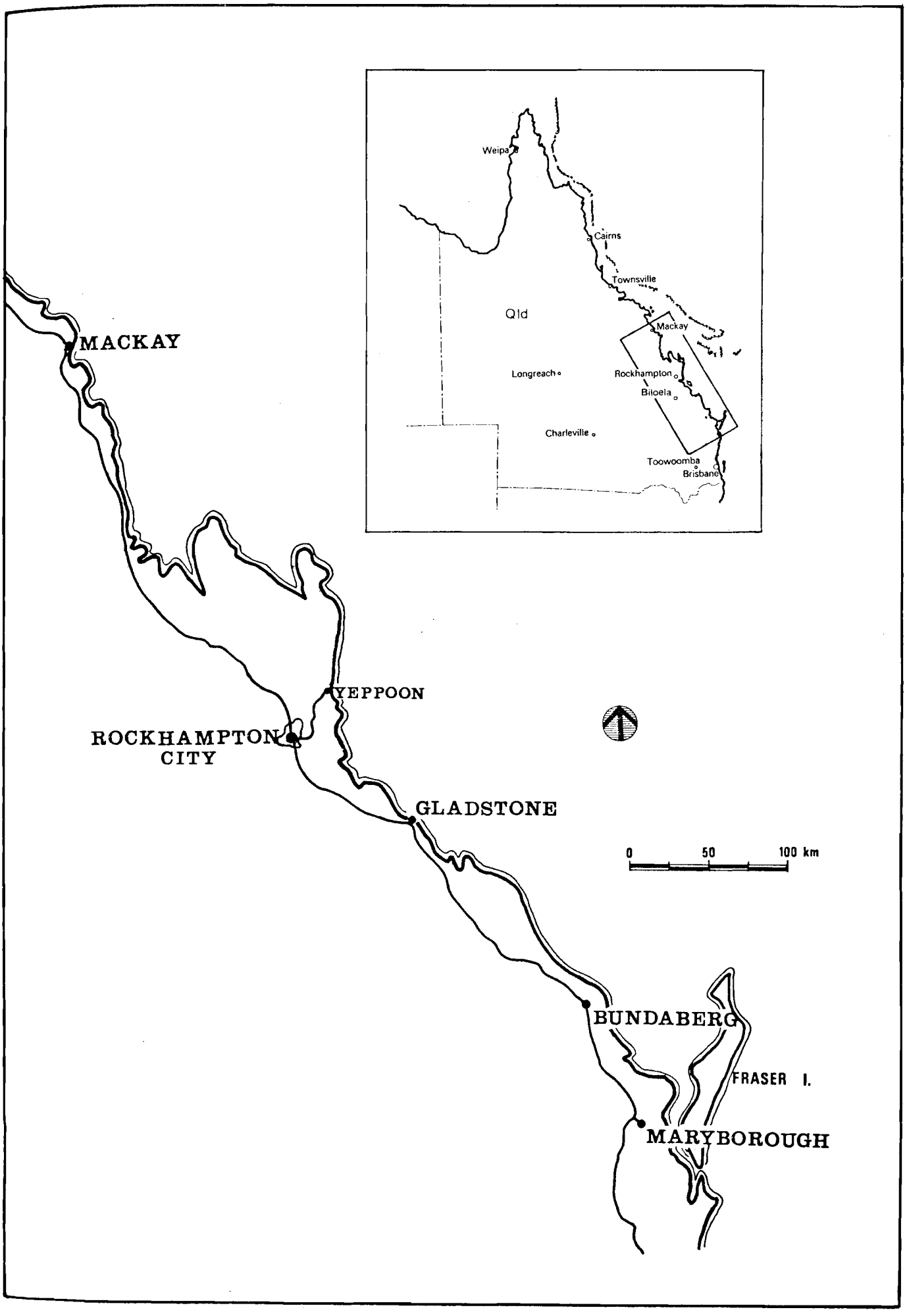
It was found that 21.7% of suitable residential land would be lost to parkland, roads and services. Thus developers could expect to achieve 11 allotments per ha. with an average size of 711.5 sq. m.

Over the first three years after development an average of 37.3% of allotments can be expected to remain vacant. However, the 'normal vacancy' rate for sub divisions over four years old was estimated at 8.4%.

Using these figures it was calculated that 2,263 occupied dwellings could be expected on the land at present zoned 'residential'. A further 1,191 could occupy the land zoned 'future residential' and 6,046 dwellings could be occupied on unzoned land.

Employing the present figure of 3.21 persons per house, it was estimated that the existing vacant allotments would be fully occupied by 1995 at current population growth rates and All residential land would be occupied by the year 2020. However, if the current growth rate of 1% p.a. increased to 5% p.a., all available residential land would be fully occupied by 1988.

Hence the study identified a possible oversupply of presently available residential allotments which might take 4 years to absorb. The land at present zoned for residential use might be adequate for the next 14 years but a serious lack of residential land can be expected to emerge at the end of the century. Then development must spread into surrounding Local Government Areas.


Weipa
Cairns
Townsville
Qld
Mackay
Longreach
Rockhampton
Biloela
Charleville
Toowoomba
Brisbane
MACKAY
YEPPOON
ROCKHAMPTON
CITY
GLADSTONE
0
50
100 km
BUNDABERG
FRASER I.
MARYBOROUGH

CHAPTER 1

Introduction

This study aims to systematically determine the availability of land in the City of Rockhampton suitable for sub division for residential purposes and to estimate the year in which the local authority will find itself without any further land suitable for future development.

A summary of the goals and objectives of this report are listed below:

Goals

To determine the possible future availability of residential allotments in Rockhampton.

To determine when the present supply of residential land will be exhausted given present population growth and Rockhampton City boundaries.

To predict the year when all suitable residential land will be used up and re-zoning will be required.

Objectives

To locate all areas of undeveloped land within Rockhampton City's boundaries.

To isolate areas not developed but in suitable residential zones.

To determine within suitable residential land, the areas of undeveloped land unsuitable for residential development because of flooding, reclamation, sewerage, or other factors.

To determine how much land will be suitable for residential purposes without the developer or purchaser having to pay abnormal development costs.

To determine the percentage of allotments which will remain vacant due to speculation or withheld from the market because of other reasons.

To determine the percentage of land lost to roads, services, parks and recreation within an area.

To calculate the maximum population able to be housed on suitable residential land.

To determine present and possible future population growth rates in Rockhampton.

To predict when all suitable residential land will be used up within the boundaries of Rockhampton City.

1.1 Factors which Influence the Supply and Demand for Residential Land

Home Ownership in Australia and Queensland

The latest Australian Bureau of Statistics survey on home ownership show that Australia now has an overall level of home ownership of 73% of households. This compares with 70% in New Zealand, and 65% in the United States, 62% in Canada and 53% in the United Kingdom (THE AUSTRALIAN. 28.5.79). Australia, therefore, would have one of the world's highest levels of private home ownership.

The levels of home ownership in Australia increased significantly after the Second World War until the late 1960's. The slow down in growth during the late 1960's was due largely to changes in the structure of the population.

The Australian Bureau of Statistics (A.B.S.) figures showed that among the States, Victoria had the highest level of home ownership with 77% of households owning or buying dwellings. In Queensland, 89.9% of total dwellings are classified as "private, occupied dwellings", while 9.4% are "private unoccupied dwellings". The remaining 0.6% belong to "non-private dwellings". Since 1971, 114,430 private dwellings and 48,598 rural dwellings have been built in Queensland. The 1976 A.B.S. survey figures further indicate that 97.5% of private dwellings in Queensland are self-contained, 1.2% are non-self-contained, 0.5% are improvised and 0.8% are mobile homes. Of the total private dwellings in Queensland 83.3% are separate houses, 13.4% are flats or home units, 0.3% are improvised dwellings and 0.7% are mobile dwellings.

Ninety-eight per cent of the Queensland population in 1976 lived in self-contained dwellings, 0.8% in non-self-contained dwellings and 0.5% in improvised dwellings with 0.7% in mobile dwellings.

The A.B.S. statistics confirm therefore, that home ownership in Australia is an extremely important goal that the individual or family strive to achieve.

Rockhampton Home Ownership

The 1976 Census revealed that 93.6% of the Rockhampton population live in private dwellings, 6.4% reside in non-private dwellings while 0.6% live in dwellings on rural holdings.

Of the total number of dwellings in Rockhampton, 93.6% are private occupied dwellings, 5.7% are private unoccupied dwellings while 0.6% are non-private dwellings.

Since 1971, 2156 private dwellings have been built in Rockhampton. The A.B.S. figures further illustrate that the majority of Rockhampton's population live in self-contained private dwellings (93.6%), 6.4% live in non-private dwellings while 0.9% and 1.5% respectively reside in improved and mobile dwellings.

Eighty-eight per cent of the dwellings in Rockhampton are separate houses, while 7.2% are flats or home units, 0.9% are improvised buildings and 1.7% are mobile dwellings.

From this analysis it is justifiable to conclude that the majority of dwellings in Rockhampton are private, self-contained dwellings.

Causes of Supply and Demand for Residential Land

A summary of the factors which influence the demand for/and supply of residential land is provided in the accompanying flow diagrams (Figure 1.2; 1.3).

The more obvious factors which influence the demand for land are the locational advantages, or alternatively the locational disadvantages of the area. Services nearby, power, sewerage, drainage, proximity to employment are important variables which will affect the demand for land in a specific area.

The population of the region will have the most profound impact on demand. As population increases so too will the demand for residential land.

The table (1.1) below illustrates the population growth in Rockhampton for the years Census data was collected. As Figures 1.2 and 1.3 illustrate, population increases are dependent upon natural growth, migration and employment opportunities in the area.

Table 1.1

Population Growth in Rockhampton 1961 - 1976

Year	Population	Average Annual Increase
1961	44128	
1966	46052	.87
1971	49141	1.32
1976	53475	1.76

Source: Rockhampton Regional Promotion Bureau

Figure 1·2

Flow Diagram: Factors Influencing Supply of Residential Land

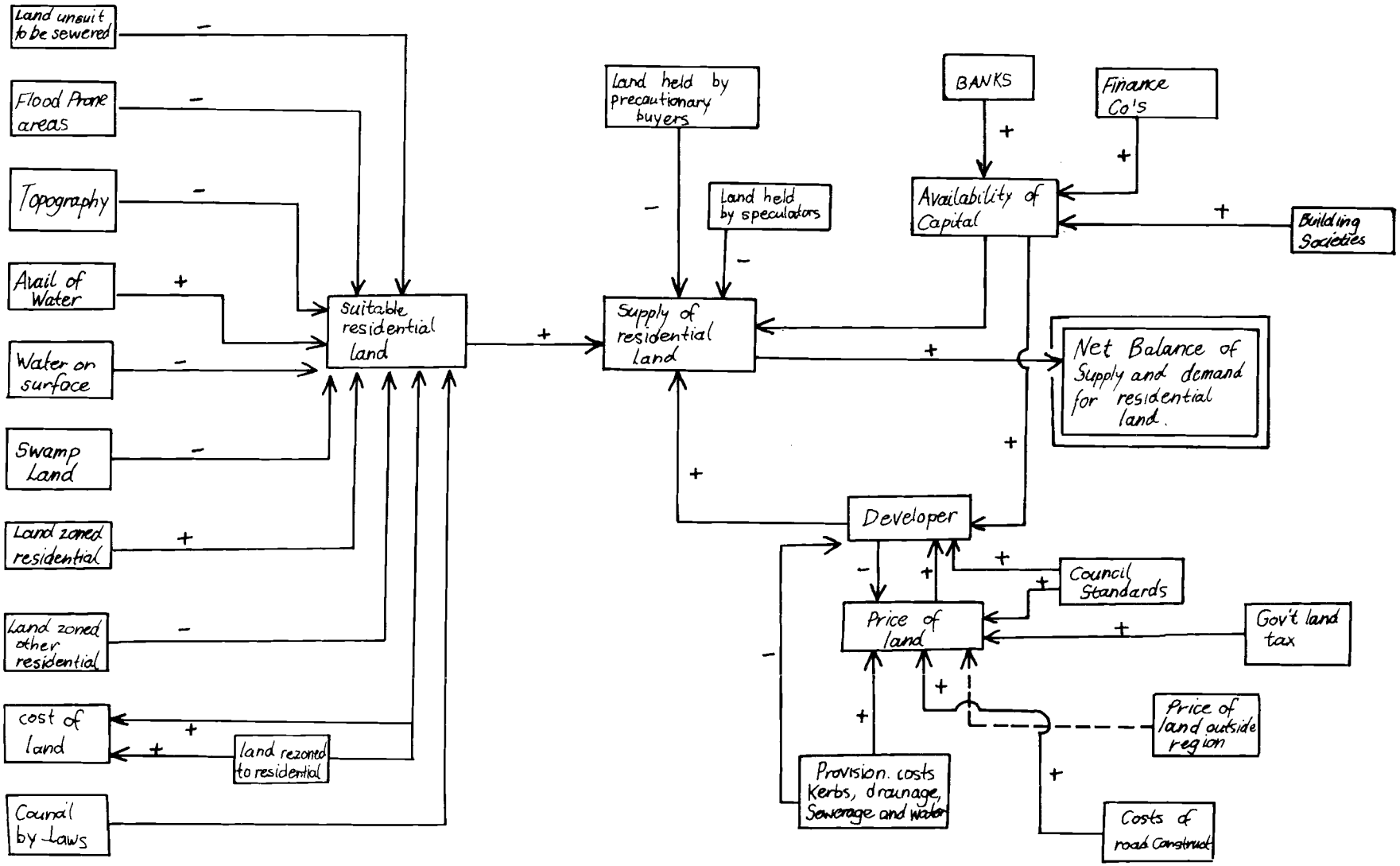
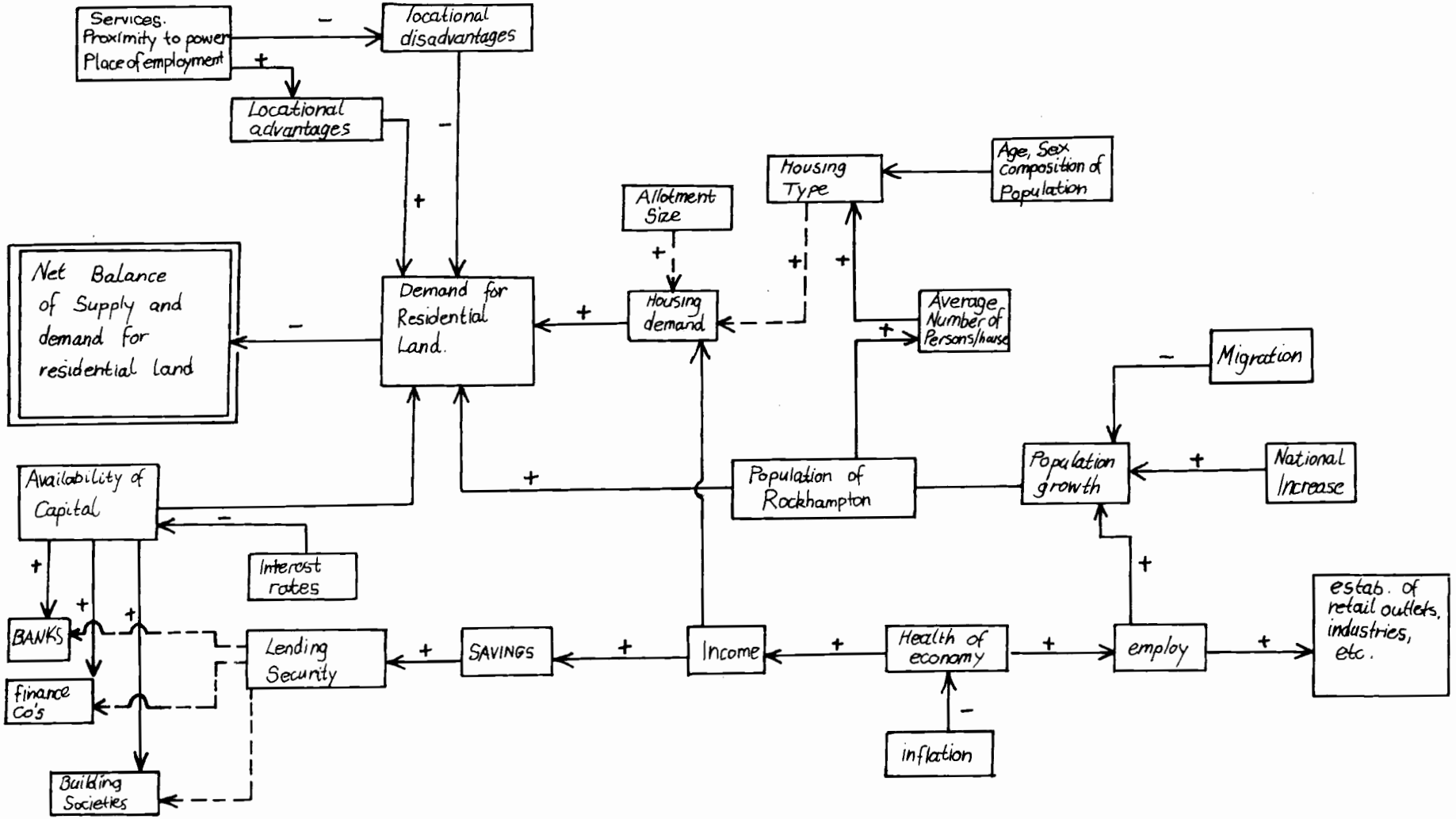


Figure 1·3

Flow Diagram: Factors Influencing Demand for Residential Land.



The availability of capital from banks, finance companies and building societies will affect the demand for residential land. The amount of liquidity in the region will be dependent upon the health of the region and the economy at large. The health of the economy will encourage or discourage employment which will lead to an increase or decrease in the total amount of income for the region.

The 1966 Census statistics show that 12,199 males and 4,429 females were employed in Rockhampton. By the 1971 Census, 12,849 males and 5,547 females were employed. With this increase of employment in the region, the income for the region must have increased. Increases in income are usually accompanied by increases in savings and expenditure. With more personal income, demand for residential housing is likely to increase.

It is obvious therefore that each component of the flow diagram influences other variables. Thus demand for residential land is influenced by a host of inter-related variables.

The actual availability, or supply, of land will likewise be dependent upon a number of variables. The obvious factor which will constrain the supply of land will be the amount of suitable land available. "Suitable" being defined as land which is not flood prone, and to which water, sewerage and power can be supplied. The zoning of surrounding land and the topography of the area will affect the suitability of land and accordingly the actual costs of the land.

The price of land both inside and outside the region is an important variable which will affect the developers' inclination to subdivide and the individual's choice of location. Costs of road construction and the costs of providing paths, kerbs, drainage, sewerage and water will affect the rate of subdivision.

More directly, government taxes and council by-laws will affect the price of land and hence the supply. Government taxes and Council by-laws will also directly influence the developers' inclination to subdivide land and hence affect supply. In addition land held by speculators and precautionary buyers will influence the supply of land.

Thus supply of land is influenced by a large number of variables. The net balance between supply and demand for residential land is the developers' major concern.

1.2 Speed of Subdivision in the Past

The Number of Allotments Subdivided in Rockhampton 1967 - 1979

Figure 1.4 illustrates the number of allotments subdivided in Rockhampton between 1967 and 1979. The immediate visual response to the graph is that subdivision has been very erratic.

To smooth these fluctuations to find any long term trend, a four-quarter moving average was taken.

The moving average (figure 1.4) illustrates two very prominent peaks in 1969 and 1973. The peak in 1969 is followed by a sharp decrease in the number of allotments subdivided, culminating in a trough in 1971 - a period defined in Australia's history as a 'mild recession'. The number of allotments subdivided fell again in 1974-1975 and remained at this level until the end of 1976, when it commenced to increase. (With the inception of the recession in 1970-1972 and the peak in 1973) The fluctuation in the number of allotments subdivided between 1967 and 1979 has very little resemblance to the Australian economic cycle of this period.

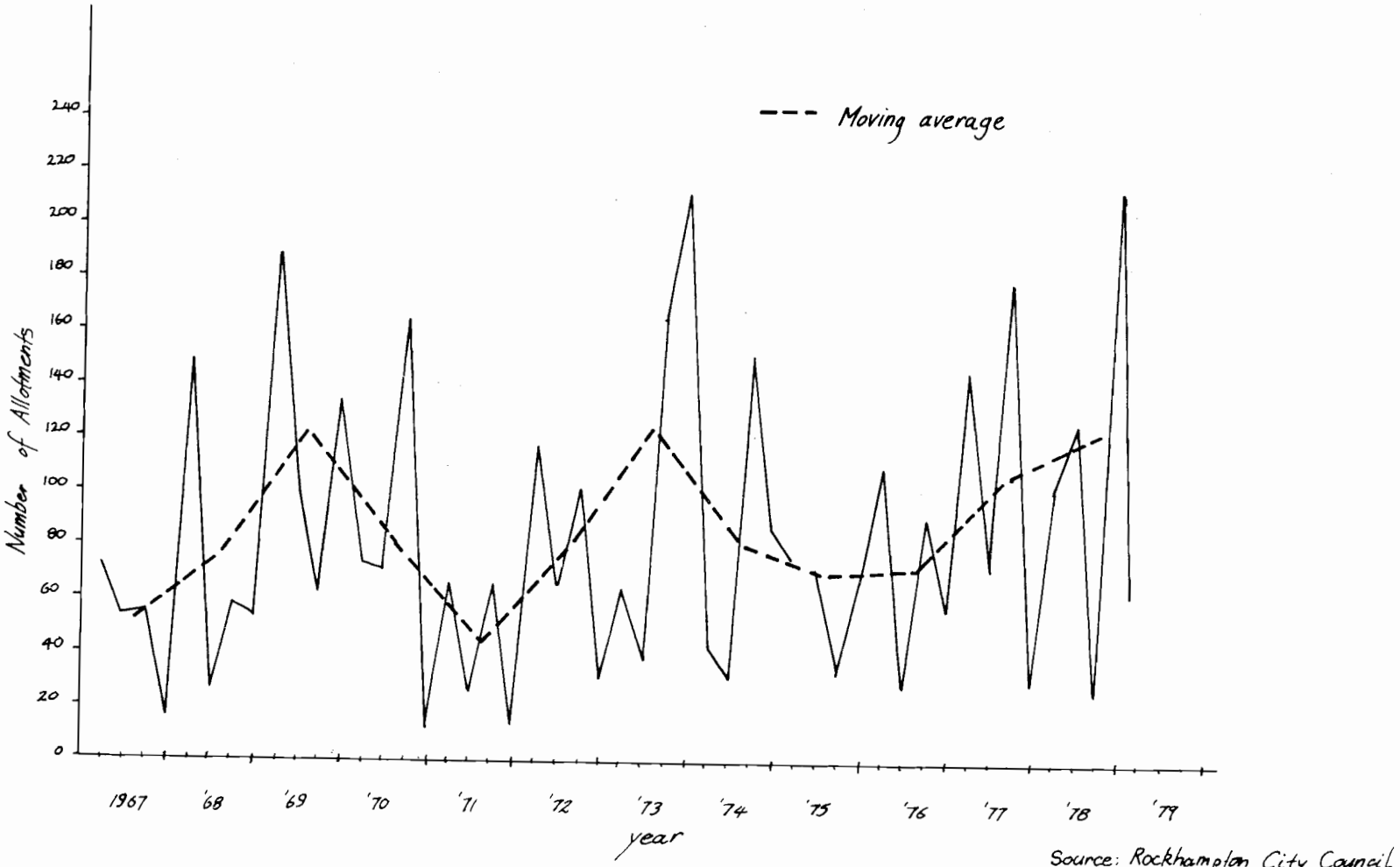
In 1970 - 1971, capital expenditure on mining (figure 1.15) peaked, but the effects from this increase were not felt in an increase in lending by major trading banks until 1972. (figure 1.16). The full effects of this increase in lending by trading banks, led in turn to a peak in 1973 in the number of new dwellings commenced in Australia (figure 1.17). Hence a time lapse can provide one possible explanation for the differing peaks in number of allotments subdivided in Rockhampton.

The peak in 1969 however, does not correspond to a peak in any of the Australian economic indicators represented. The increase in allotments subdivided in this year must have been a response to local and regional demands.

The trough in 1971 - 1972 and 1974 - 1975 however, reflect the recessions in Australia.

In 1971 - 1972, prices were increasing at a rate of 5.4% (according to C.P.I. figures), the highest in the decade. The period also witnessed worsening rural conditions. Growth in consumption fell from 5.6% in 1969 - 1970 to little over 3% in 1970 - 1971. Expenditure on dwellings was subdued throughout this period. The number of commencements of dwellings which had increased by 2.8% in 1969 - 1970

Figure 1.4
Number of allotments subdivided.
1967-1979



Source: Rockhampton City Council

fell by about 6 % in 1970 - 1971.

The period 1974 - 1975 was characterized by high levels of inflation, uncertainty, falls in private spending, and number of dwellings commenced in Australia. Demand fell in real terms and Real Gross Domestic Product (figure 1.12) declined by close to 2%.

The Number of Houses Approved in Rockhampton 1967 - 1979

The number of new dwellings approved in Rockhampton between 1967 and 1979 is illustrated in figure 1.5. The curve shape is erratic, reaching many peaks and troughs. The highest peak in 1973, corresponds to the 1973 peak in the number of dwellings commenced in Australia. However the sharp drop in dwellings in Australia, evident in 1974 - 1975 did not show itself until 1976 - 1977 in Rockhampton.

The number of dwellings approved in Rockhampton reached a minor peak in 1967 - 1968. A fall in the number of dwellings approved occurred in 1969, then it remained at a stable level until 1970. In 1971 - 1972 the number of dwellings approved fell sharply terminating in a trough in early 1971. By the end of 1972, the number of dwellings approved commenced to increase to peak in 1973. Between 1973 and 1977, dwellings approved fell culminating in a trough in 1977. Since 1977 the number of dwellings approved has been increasing.

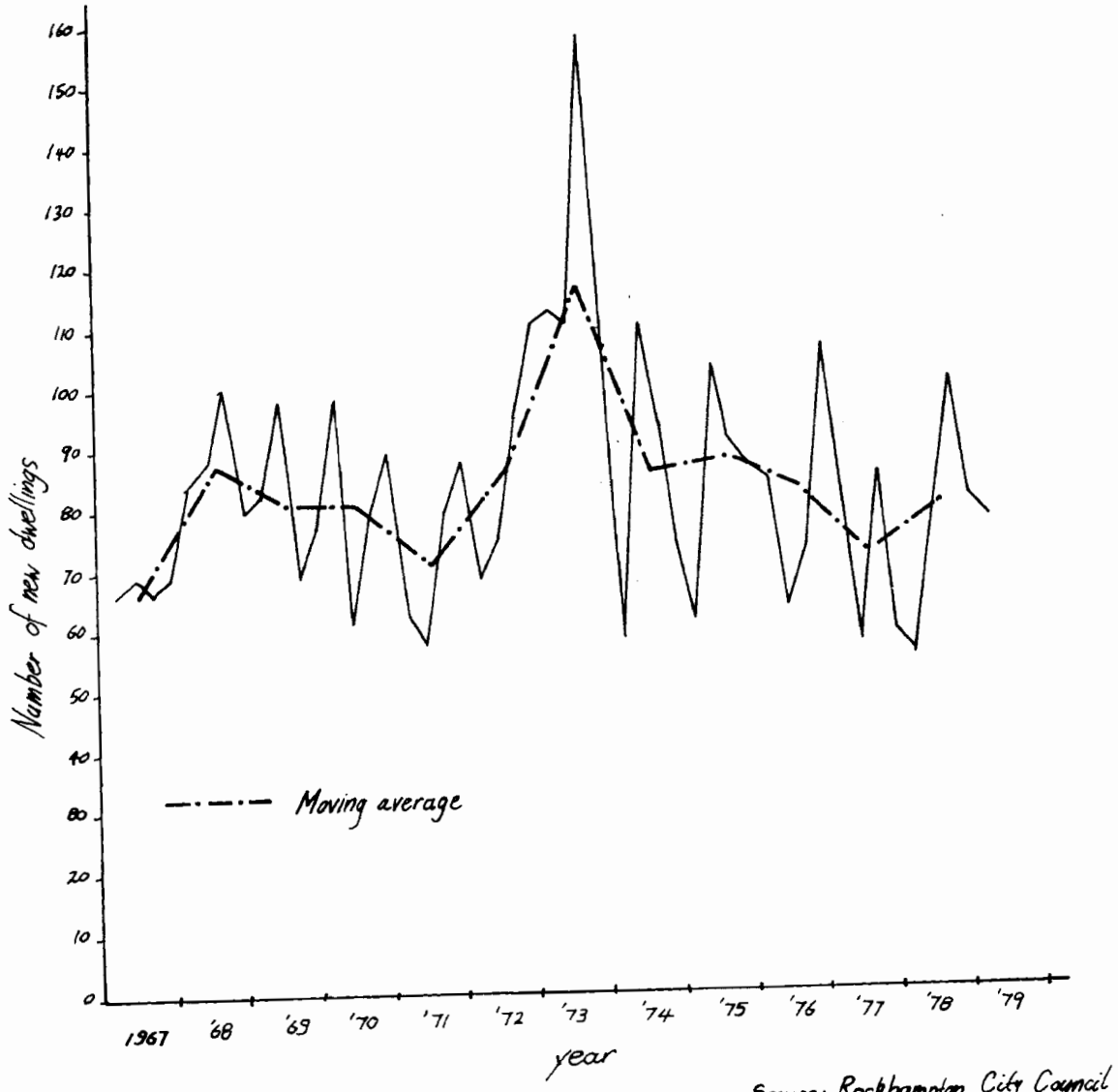
The number of dwellings approved in Australia peaked in 1973 and sharply fell away in 1974 - 1975. In 1967 the number of dwellings commenced in Australia was atill at a low level. Hence the peak in dwellings approved in Rockhampton in 1967 must only have reflected local or regional economic conditions.

The 1971 trough and the 1973 peak, in the number of buildings approved in Rockhampton may have to some extent reflected the general health of the Australian economy in 1971 (a period of recession) and 1973 (a period of cyclical expansion).

According to D.I.Webb,* cyclical fluctuations in construction activity will vary from place to place based on temporal fluctuations in local demand. He goes on to say "that as a result of this inflexibility in total supply, relatively small increases in local demand can be met only by large fluctuation in marginal supply which is new activity."

Webb, outlined a statistical model to analyse the relationship

Figure 1.5
Number of new dwellings approved in Rockhampton. (1967-79)



Source: Rockhampton City Council

between national housing activity and its regional components.

The model is based on one developed by Brechling (1967) to examine regional difference in unemployment.

Webb produced a regression coefficient (a) to effectively describe the relationship between national and regional fluctuations in housing activity. The coefficient provides a measure of the sensitivity of the local housing sector to changes in national housing activity over time.

If a > 1, the region's cyclical fluctuations are more severe than those of the nation as a whole.

Rockhampton's (a) regression coefficient is equal to .358 (significant at 95 per cent level). Thus, strength is given to support the previous statement - it is more likely that Rockhampton responds to regional cyclical fluctuations than those of the nation as a whole.

Figure 1.6 illustrates the number of flats built in Rockhampton between 1970 - 1978. The number of flats built in Rockhampton is minimal in comparison to the total number of dwellings approved. Although the moving-average curve shows a definite decline in flat numbers in 1974, absolute figures indicate the decline is negligible, (a fall of only eight flats).

Relationship between the Number of Dwellings Approved in Rockhampton and the Number of Allotments Subdivided

Figure 1.7 illustrates the number of allotments subdivided and the number of houses approved in the form of a 'relative cumulative frequency curve'.

Both curves are similar in that the number of houses approved is increasing at a constant rate and the number of allotments subdivided is also increasing at a steady rate but with rather more fluctuation, Both curves illustrate a temporary levelling out in the recessionary period of 1971 - 1972. The two curves further illustrate a more rapid increase in both total number of houses approved and total number of allotments subdivided since 1973.

Figure 1.8 and 1.9 seek to examine the relationship between the number of houses approved and the number of allotments subdivided. If

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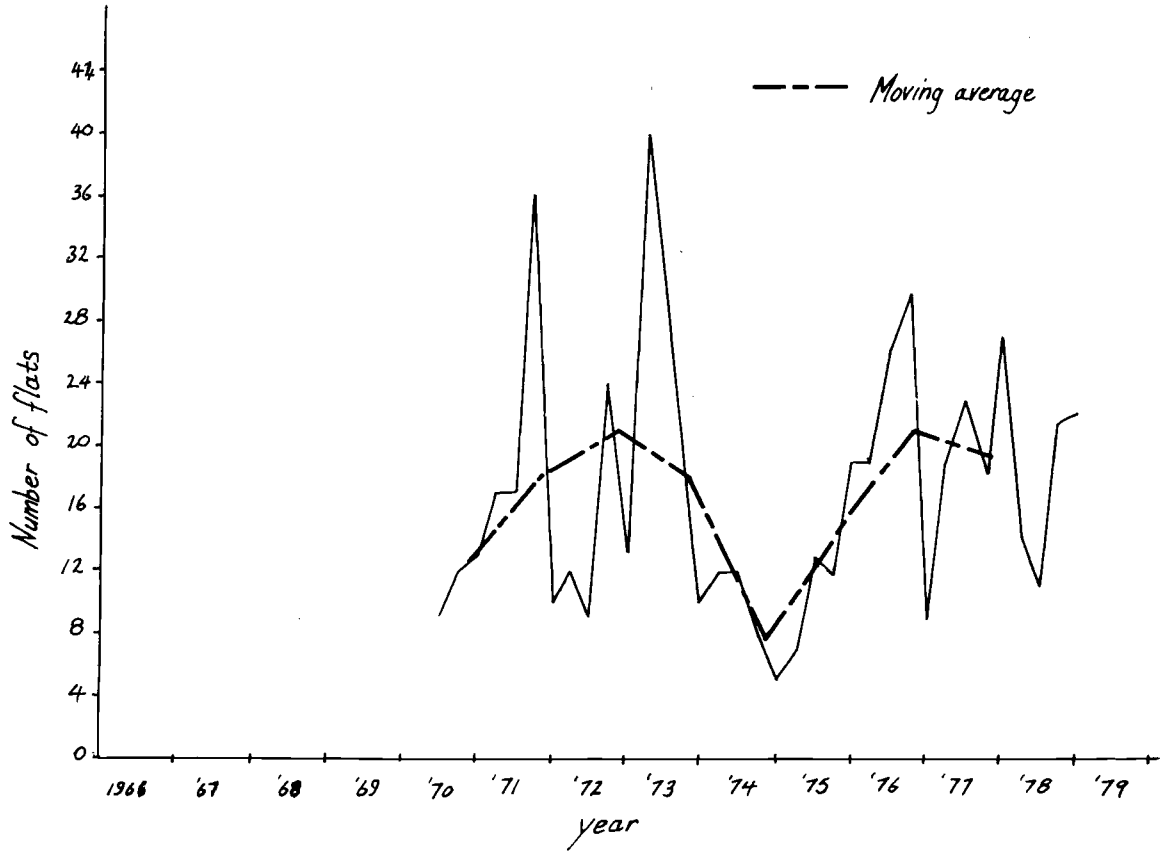
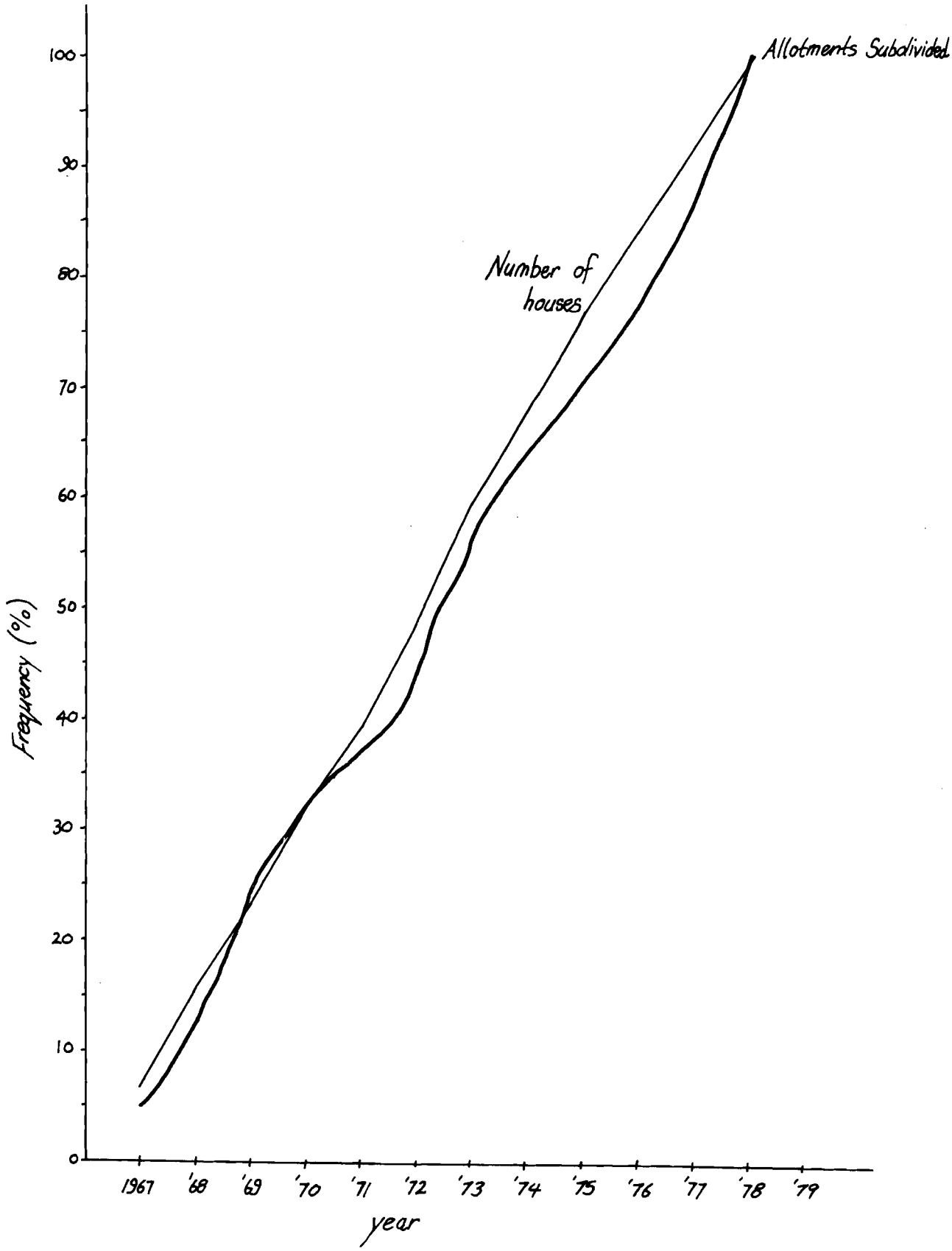
* Webb D.I., 'The Cyclical Nature of Residential Construction in Australia 1955 - 1972: Some Regional Considerations' Economic Geography Vol. 1979, p84.

Figure 1.6
Number of flats built in Rockhampton
(1970-78)



Source: Rockhampton City Council

Fig. 1.7
Relative cumulative frequency of number of allotments subdivided (1967-79) and number of houses approved.



Source: Rockhampton City Council

any relationship exists, it is likely that the demand for housing is determining the number of allotments subdivided.

Figure 1.8 clearly indicates that no relationship exists. That is, any increase in the number of houses approved will not necessarily increase the number of allotments subdivided.

The correlation coefficient r is calculated as .2165. This strengthens the support in favour of there being very little relationship between the numbers of allotments subdivided and the number of dwellings approved. The coefficient of determination r^2 is equal to 0.047. Thus only 4.7% of the variation in the number of allotments subdivided can be attributed to the number of dwellings approved. If the relationship is smoothed, by the use of 'moving averages' (figure 1.9) a stronger but still weak relationship is found to exist.

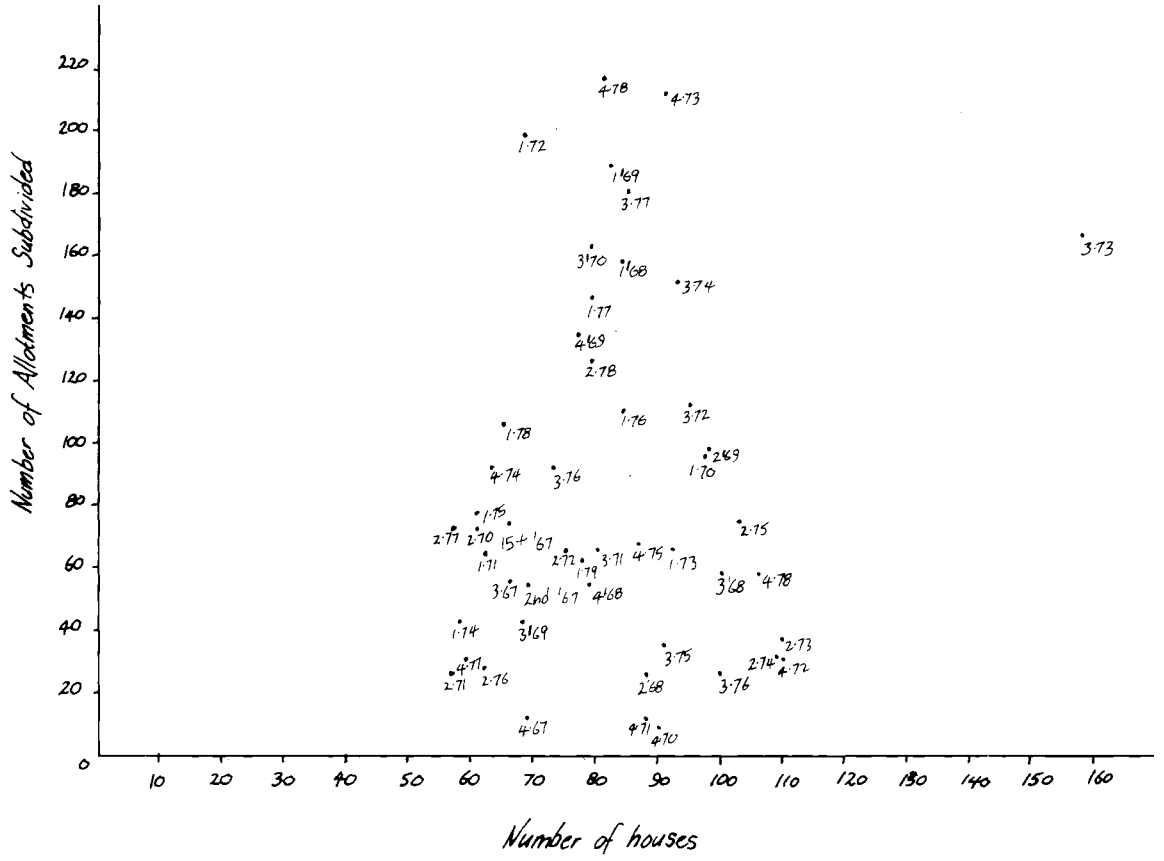
Figure 1.10, Changes in stock of allotments available in Rockhampton from January 1967 , is the most useful of all statistical evidence available so far.

The graph highlights a number of important facts:
From 1967 to the middle of 1968 a decreasing inventory in subdivided allotments is indicated. During this period therefore developers were more inclined to increase the number of dwellings than the number of allotments. By mid 1968, the number of allotments subdivided commenced to increase, peaking in mid 1970. Here, for the first time since 1967, the number of allotments created far exceeded the number of dwellings approved. It is possible therefore, that towards the end of this period an over supply of allotments emerged.

From mid 1970 to 1977, the graph illustrates a sharply decreasing inventory, once again depicting the fact that more dwellings were approved than the number of allotments created by new subdivisions.

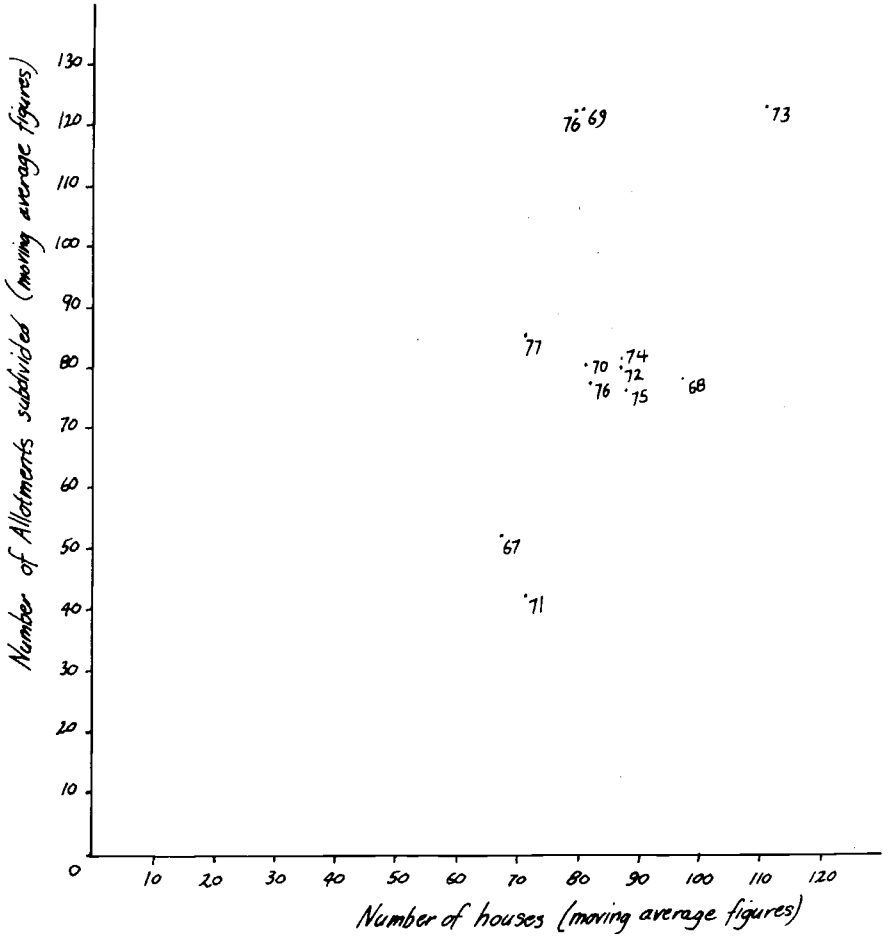
By the end of the building boom in 1972 - 1973, there may have been a shortage in the number of allotments. Consequently the downturn in construction activity was not reflected in a similar downturn in subdivision activity which continued unabated. However, from the beginning of 1977 to the end of 1978 there has been an increasing inventory of allotments subdivided with a continuous decrease in the number of new dwellings approved. Hence the prospect of an over supply in residential allotments has begun to emerge.

Figure 1.8
Relationship between number of allotments subdivided and number of houses.
1967-79 (approved)



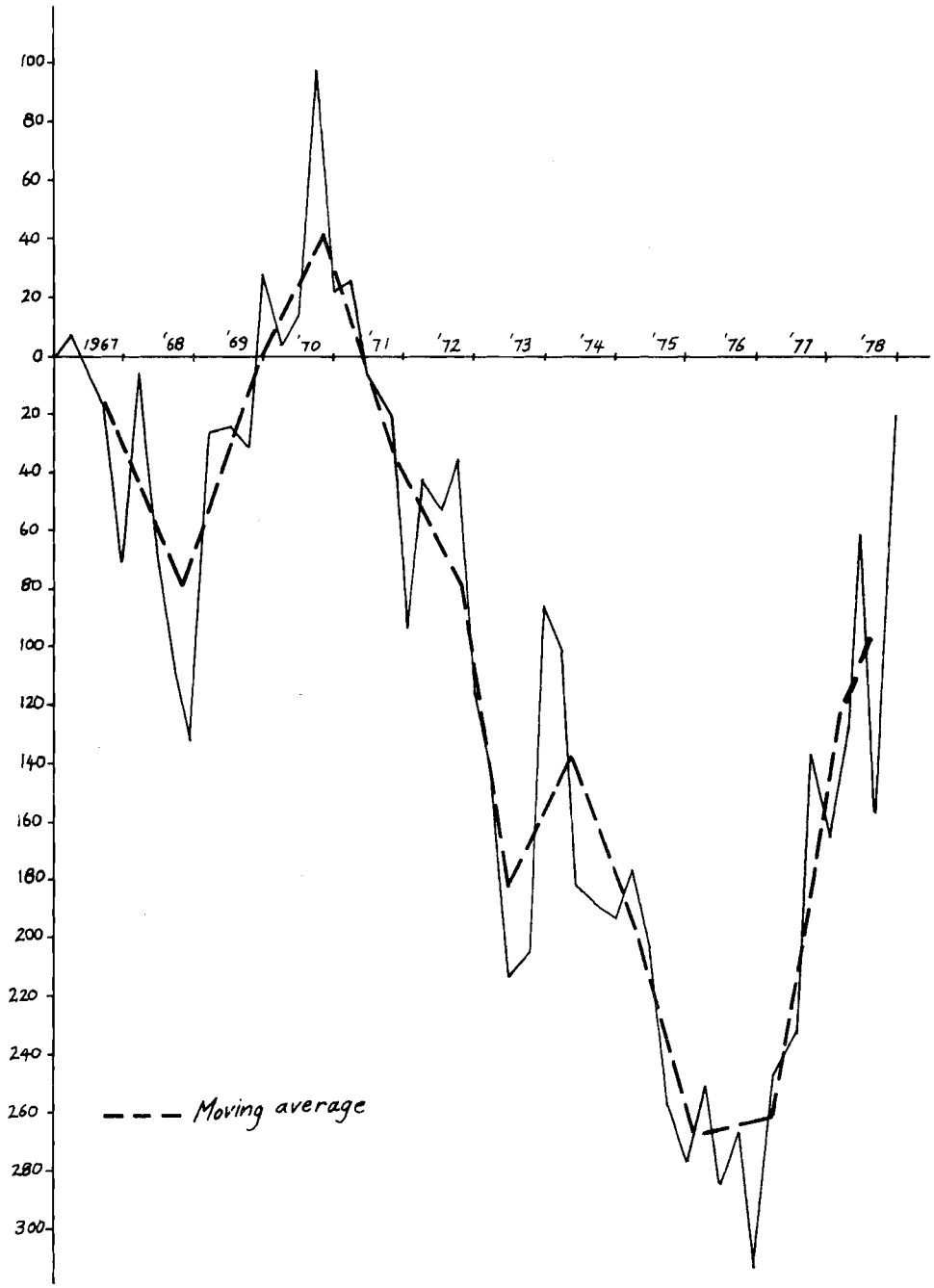
Source: Rockhampton City Council

Fig.1.9
Relationship betweem number of houses approved in Rockhampton and number of allotments subdivided between 1967 and 1978. (Using moving average figures)



Source: Rockhampton City Council

Figure 1.10
Changes in stocks of allotments available in Rockhampton from January 1967.



Source: Rockhampton City Council

By the end of 1978, the inventory position has returned to the same position as the mid 1960's. If this increasing inventory continues into the early 1980's, Rockhampton may well find itself in a major oversupply of residential sites, which may be more critical than the 1970 - 1971 oversupply.

Conclusion

On the basis of the preceding research, the following conclusions have been reached.

(1) The number of allotments subdivided in Rockhampton does not necessarily reflect Australian economic conditions.

(2) The number of dwellings approved in Rockhampton does not necessarily reflect Australian economic conditions.

(3) Number of allotments subdivided in Rockhampton and the number of dwellings approved in Rockhampton tend to reflect local or regional economic trends.

(4) No direct relationship exists between number of allotments subdivided in Rockhampton and number of dwellings approved.

(5) In 1970 - 1971 Rockhampton experienced an oversupply of residential sites.

(6) in 1972 - 1973 Rockhampton witnessed the end of the building boom but there may have been a continuing shortage of allotments.

(7) Subdivision then continued in Rockhampton at a faster rate than new residences were being commenced.

(8) If present trends continue, Rockhampton may experience an oversupply of stocks, a situation which will be more critical than the 1972 - 1973 situation.

Figure 1.11
Total new dwellings commenced

Figure 1.12
Gross domestic product at current prices
$ Million

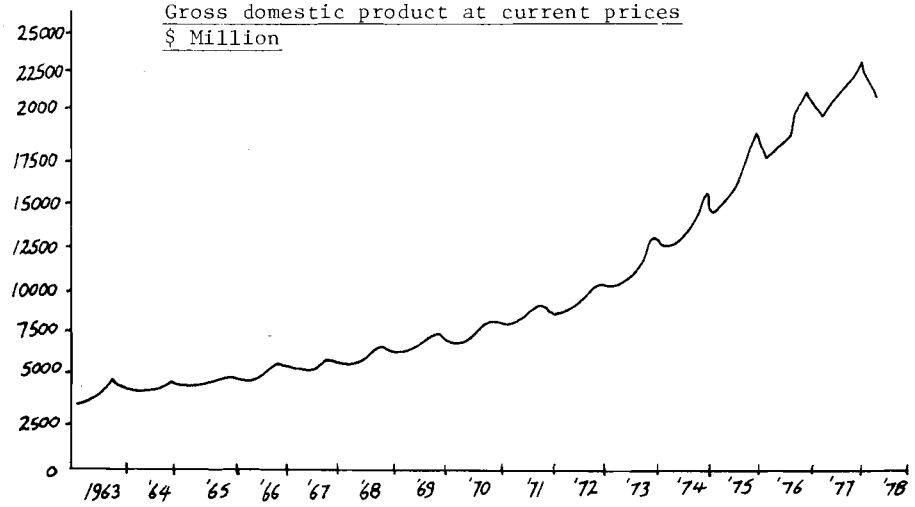
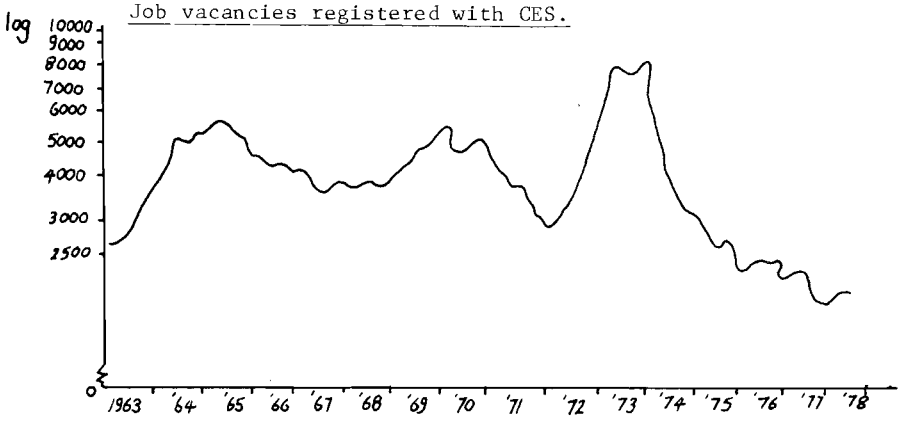


Figure 1.13
Job vacancies registered with CES.



Source: Economic Indicators - Australia 1978

Selected Indicators of Australian Economic Activity
1958 to 1976

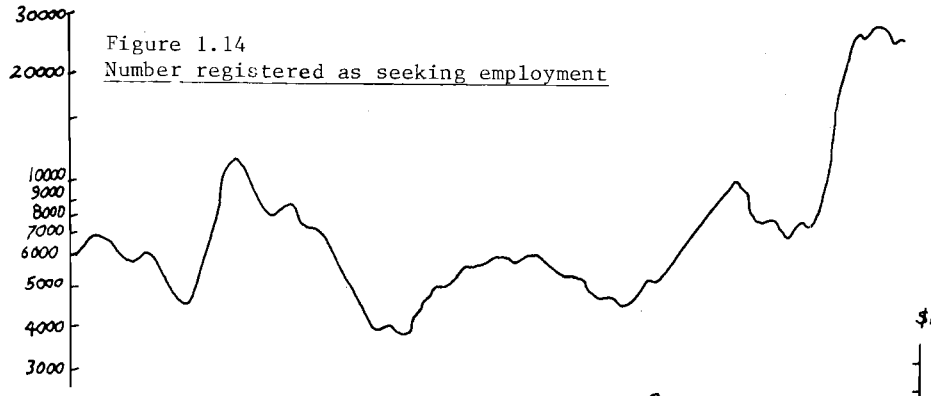
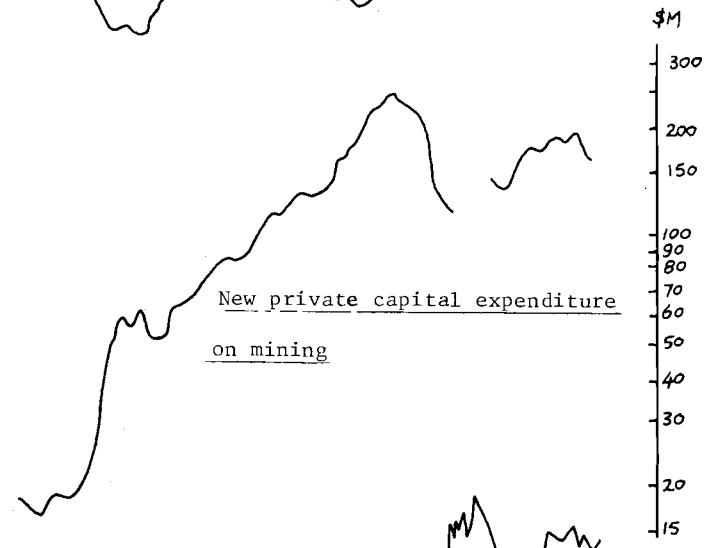


Figure 1.14
Number registered as seeking employment

Figure 1.15



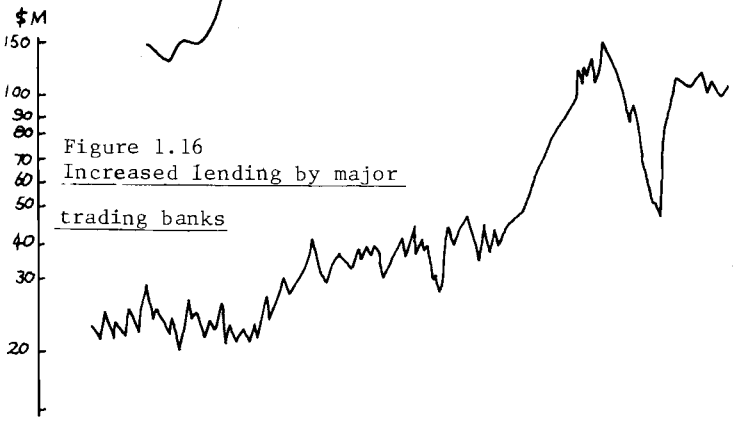
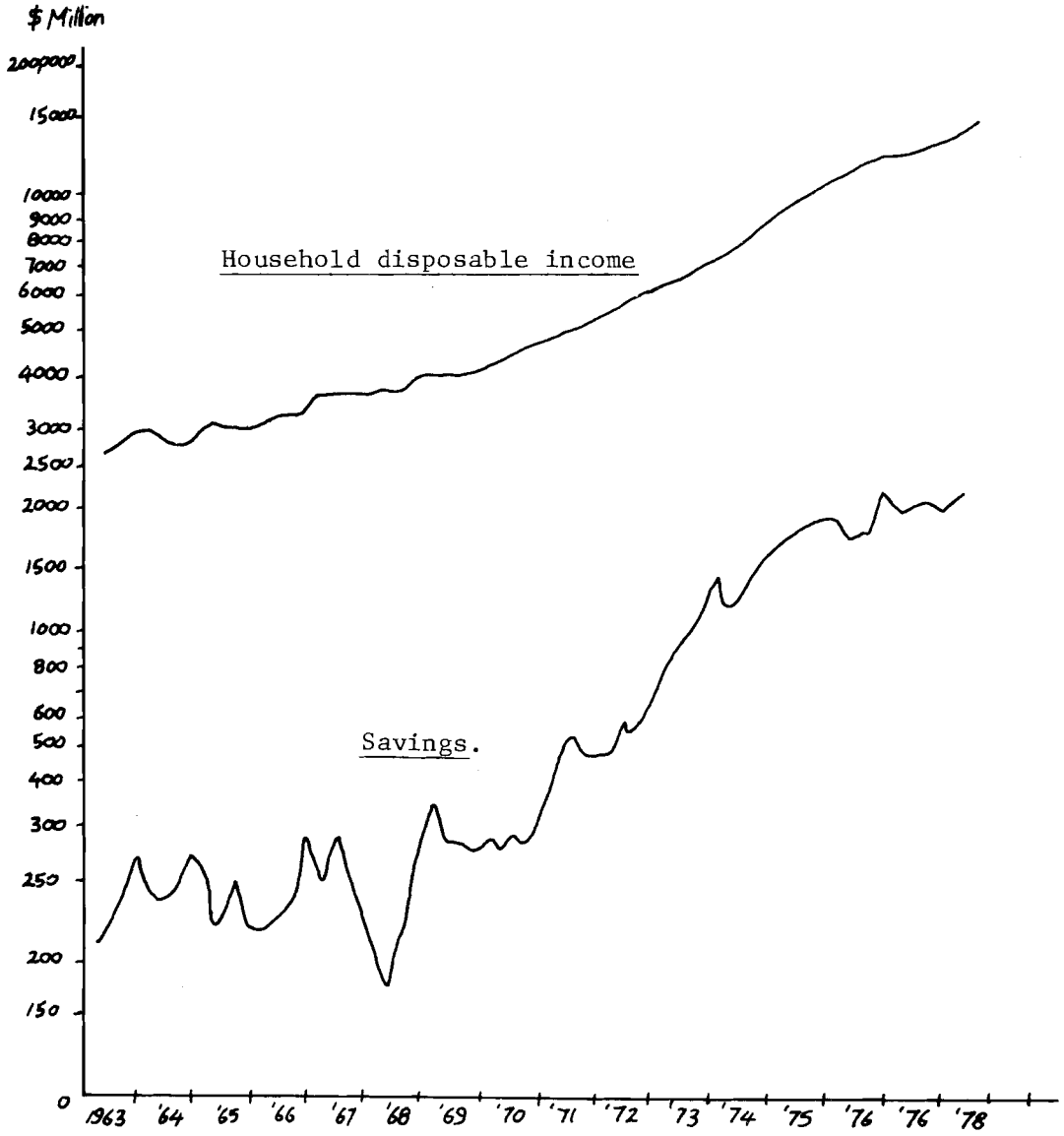


Figure 1.16
Increased lending by major trading banks

Figure 1.17
Number of new dwellings commenced

Figure 1.18


$ Million
20000
15000
10000
9000
8000
7000
6000
5000
4000
3000
2500
2000
1500
1000
800
600
500
400
300
250
200
150
0
Household disposable income
Savings.
1963
'64
'65
'66
'67
'68
'69
'70
'71
'72
'73
'74
'75
'76
'76
'78

1.3 Council Regulations Controlling Residential Development

This section of the report represents a statement of Council Regulations controlling the areas where residential development may occur, and the types and specifications of buildings that may be erected.

Land Zonings

All land in Rockhampton City is zoned according to the Town Planning Scheme adopted in 1970.

Under this scheme, there are fourteen zones. Each zone denotes which purposes are permitted and which purposes are prohibited in that zone. The fourteen zones are: Non-Urban 'A', Non-Urban 'B', Future-Urban 'A', Future-Urban 'B', Residential, Central Business, Local Business, General Industry, Noxious or Offensive Industry, Hazardous Industry, Extractive Industry, Service Industry, Parks and Recreation, and Special Uses.

Since this study is concerned with residential development, then only zones where dwelling-houses may be erected are important. This fact narrows our concern down to three zones. These are: Future-Urban 'A', Future-Urban 'B', and Residential. The Council Regulations as they relate to these zones are shown in Table 1.2 on the following page.

Flood-prone Land

The Rockhampton City Council has applied the 1954 flood line as the basis for preventing residential development in flood-prone areas. No dwelling may be erected or rebuilt on land which was

TABLE 1.2

Land-Use Zonings in Rockhampton

COLUMN I	COLUMN II	COLUMN III	COLUMN IV	COLUMN V
Zone	Colour on Scheme maps	'Of right' uses	'Consent uses'	'Prohibited uses'
3. Future-Urban "A"	Light-scarlet with brown edging, and scarlet hatching	Agriculture; Dwelling-houses (if erected on allotments having an area of at least ten acres); Forestry	Dwelling-houses, (if erected on allotments in existence on the appointed day). Any other purposes other than those permitted by Column III or prohibited by Column V.	Bulk Stores; Camps; Car Repair Stations; Commercial premises; Dwelling-houses (except as specified in Columns III and IV); Extractive Industries; Generating Works; Hazardous Industries; Institutions; Liquid Fuel Depots; Milk Distribution Depots; Motor Showrooms; Noxious or Offensive Industries; Rural Industries; Service Industries; Transport Terminals; Undertakers' Establishments; Warehouses
4. Future-Urban "B"	Light-scarlet with brown edging	Agriculture; Dwelling-houses (if erected on allotments having an area of at least ten acres); Forestry	Dwelling-houses (if erected on allotments in existence on the appointed day). Any other purposes other than those permitted by Column III or prohibited by Column V.	Bulk Stores; Camps; Car Repair Stations; Commercial Premises; Dwelling-houses (except as specified in Columns III and IV); Extractive Industries, Funeral Parlours; General Industries, Generating Works; Hazardous Industries; Institutions; Liquid Fuel Depots; Milk Distribution Depots; Motor Showrooms; Multiple Dwellings; Noxious or Offensive Industries; Rural Industries; Service Industries; Shops; Transport Terminals; Undertakers' Establishments; Warehouses.

TABLE 1.2 (Cont'd.)

5. Residential	Light-scarlet	Dwelling-houses	Any purposes other than those permitted by Column III or prohibited by Column V.	Bulk Stores; Camps; Car Repair Stations; Commercial Premises; Extractive Industries; Funeral Parlours; General Industries; Generating Works; Hazardous Industries; Institutions; Liquid Fuel Depots; Motor Showrooms; Noxious or Offensive Industries; Rural Industries; Service Industries; Transport Terminals; Undertakers' Establishments; Warehouses.

Source: Rockhampton City Planning Scheme

covered by two feet or more of water during the peak of the 1954 flood. This policy applies to residential buildings only.

Land that is flood-prone, no matter if it is in a residential zone, cannot be built on.

Reclaimed Land

The Council Regulation concerning reclaimed land states that reclaimed land cannot be built on for residential purposes and only in special circumstances for other uses. The reason behind the regulation is the problem of subsidence due to lack of adequate foundations in such areas.

Building Regulations

Residential dwellings are controlled in Rockhampton through the Rockhampton City Council Building Regulations which are Section Four of the City By-Laws.

The regulations cited below represent the most important requirements imposed by the City Council on residential constructions. A more detailed summary of requirements is shown in Tables 1.3 and 1.4.

The minimum area of any allotment on which a dwelling is permitted is six hundred square metres.

The maximum site coverage for any allotment is fifty percent. This means that at least fifty percent of the allotment on which the dwelling is to be built, must be free of any structures.

Dwellings may only be built in residential areas approved by the Council or Town Plan.

TABLE 1.3

Summary of Major Requirements for Residential Dwellings in Rockhampton

SUMMARY OF MAJOR REQUIREMENTS:

DWELLINGS:

Minimum Area of Allotment (New Surveys)	600 m^2
Minimum Frontage of Allotment (New Surveys)	20 m_2
Minimum Area of Dwelling (Single Unit)	63 m^2
Minimum Distance from Front Allignment (See Back)	6 m

New surveys only - Existing surveys not affected.

Any situation differing from this must be applied for through the Town Clerk.

Minimum Distance from Side and Rear Allignment 1.25 m.
(Refer to back of sheet)

Minimum Distance E.C. from Dwelling...	6.09m
Minimum Footing Depth	0.6 m
Minimum Bearer Clearance to ground	0.6 m
Minimum Bearer Clearance with surrounding vented rat baffle	225 mm
Minimum Ceiling Height from floor, habitable rooms ...	2400 mm
Minimum Veranda Height from floor ... ... average.	2300 mm
Minimum Window Glazing habitable rooms 10% floor area	
Minimum Depth of Rat Baffle Wall below ground	0.6 m
Minimum Thickness of Rat Baffle Wall below ground	75 mm
Stump Bracing: To corner stumps (including concrete stumps higher than	1.25 m

W.C. to be 1500 mm x 900 mm x 2100 high, with (0.36m^2) fixed glass louvres, well separated from food preparation and eating areas.

HOUSE NUMBERS:

Will be placed on the Back of House Plans when issued for New Dwellings. The Contractor is requested to advise the Purchaser/Owners of this number.

Site Coverage ... ... maximum 50%

FLATS (Permitted in Sewered Area Only):

Minimum Area of Allotment to Council Approval per flat Flat, subject to special determination by the Council, where Flats of more than one storey are to be erected, Flat premises not to be permitted on any allotment of land under 600 m^2.

AREAS FOR UNITS:

One Bedroom Unit	now 37 m^2
Two Bedroom Unit	now 50 m^2

Plus 11.5 m^2 for each additional 1 Bedroom.

Source: Building Regulations,
Section Four of Rockhampton City By-laws.

TABLE 1.4

Summary of Major Requirements for Flats in Rockhampton City

REQUIREMENTS FOR FLATS:

Corner Sites 4.6 m each way.
Clearances to Rear and Side Alignments 2 in Ground Floor plus 0.6 m each additional floor.
Garage space required 16 m^2 for each unit.
Minimum Frontage ... ... 20 m
Minimum Area of Flats.
1 Bedroom ... ... 37 sq. metres
2 Bedrooms ... ... 50 sq. metres
Each Additional Bedroom ... ... 11.57 sq. metres
Minimum Distance to Front Alignment ... ... 7 m
Minimum Distance to Side Alignment ... ... 2 m
No Internal Rooms Permitted.
Separate Entry and Exit for each flat.
Minimum Requirements 2 Widely Separated Entrances to each Flat.
Separate Bath and Toilet, Wash Hand Basin, Laundry, Clothes Hoist for each flat and sound-proofed dividing walls; other-wise requirements as for dwellings.
All units must be of first-class construction, i.e., Brick, etc., for all external walls and walls separating units.

Unit Division Walls: Where dwelling units are less than six storeys high, the dividing wall may not be required to extent to the underside of the roof sheeting provided -
(a) The roof covering is non-combustible and
(b) The ceiling immediately below the roof has a resistance to the incipient spread of fire to the roof space of one hour, as determined in the Standard Fire Test.

Fire Brigade:
Plans of Multiple Units must be submitted to the Fire Safety Officer before being submitted to the Council; all plans must carry the endorsement of the Fire Safety Officer on the three copies.

MULTI STOREY:

Lift to be provided where building exceeds five storeys on the basis of twenty gallons per person.
Multi-Storey Units of different occupancy require sound insulation between floor and ceiling and at least 1 hour fire rated ceiling sheeting.
Where more than two flats are being built a Fire Extinguisher to each flat is required.
NOTE: Special Types of Extinguishers are required where Electrical Power is used.

Source: Building Regulations,
Section Four of Rockhampton City By-Laws.

The preceding requirements are common to all types of residential dwellings. However, flats have additional controls imposed upon them. These are as follows.

The maximum number of flat allotments for any residential area is twenty-five percent of the total area. This is because the Building Regulations require that there be three house allotments between each flat allotment.

Each flat unit must face a street.

Each flat unit must be made of first-class material such as brick or rock block.

The flat regulations mentioned pertain to flats of one or two storeys. Added regulations are enforced on flats of more than two storeys. See Table 1.4.

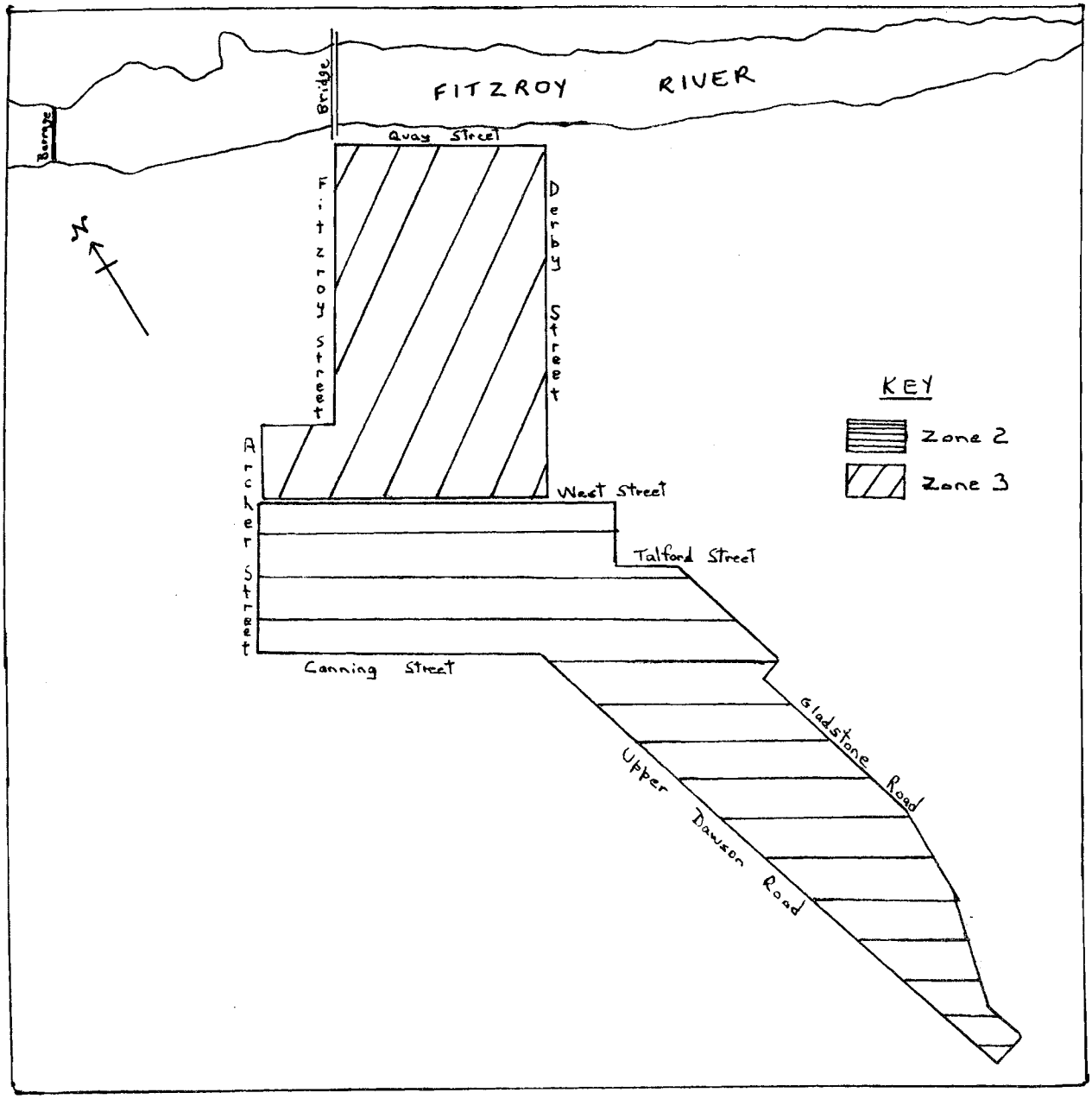
Zonings for Flats

The Rockhampton City Council has divided Rockhampton into three zones: Zone One - White, Zone Two - Blue, and Zone Three - Red. Each colour represents a different number of storeys permissible for flat premises.

All the areas in Rockhampton are zoned 'white' except four pockets of blue and red zonings. Flats of one or two storeys are allowed in the 'white' zone. Zones Two and Three allow flats of greater than two storeys but these zones are in old established residential areas. Any new subdivisions will be zoned 'white'. Figures 1.19 and 1.20 show the areas of blue and red zoning in Rockhampton.

FIGURE 1.19

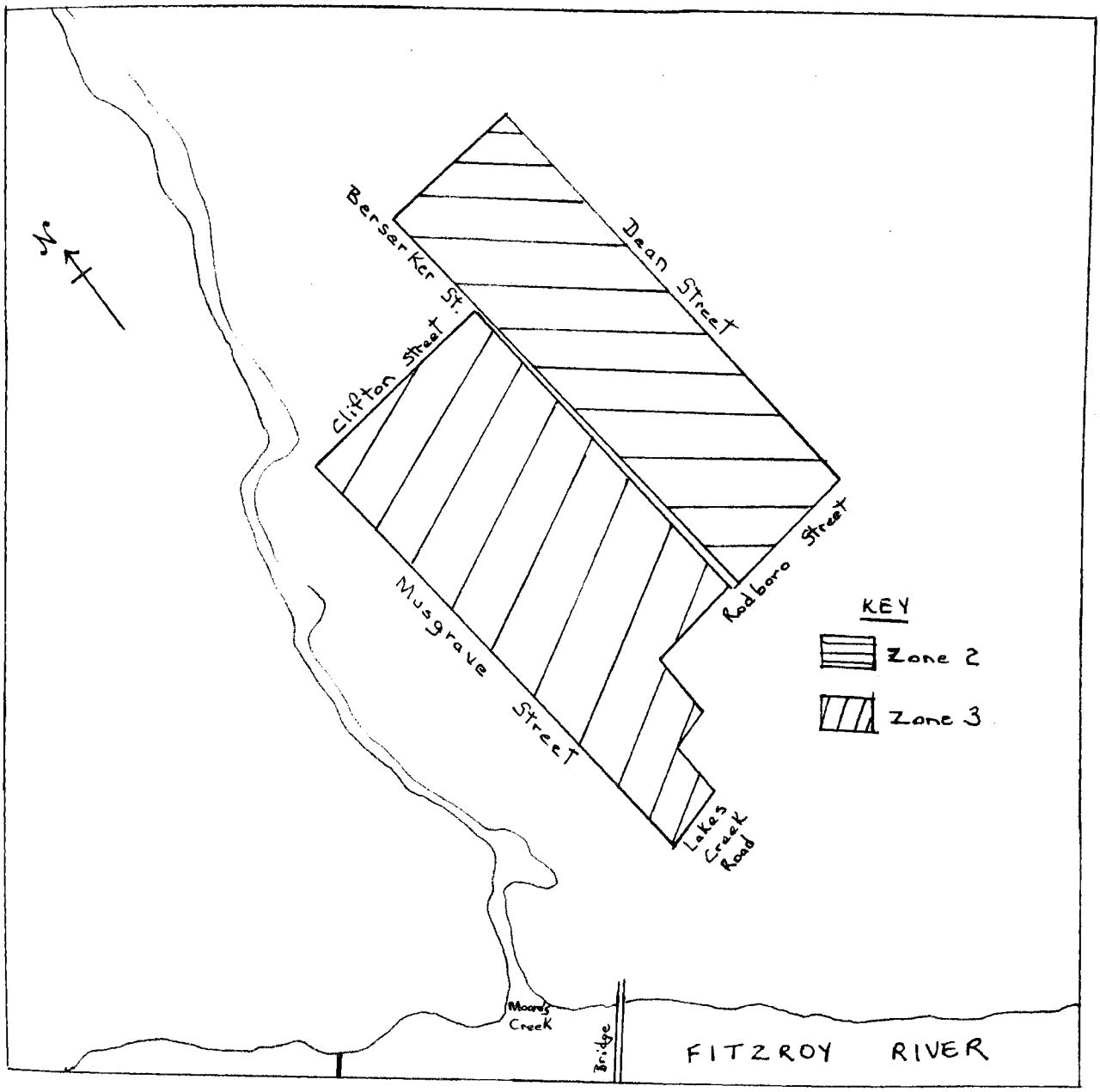
Map showing flat zonings in South Rockhampton



Source : Building Inspector,
Rockhampton City Council.

FIGURE 1.20

Map showing flat zonings in North Rockhampton



Source: Building Inspector,
Rockhampton City Council.

Conclusions

The result of this discussion is that residential development in Rockhampton will initially occur only in those areas zoned either Future-Urban 'A', Future-Urban 'B', or Residential. These zones were set out by the 1970 Town Planning Scheme. Residential development cannot take place in flood-prone areas or on reclaimed land. Flat premises in new subdivisions will be one or two storeys. All residential allotments will cover an area of at least six hundred square metres and be in accordance with City Building Regulations.

CHAPTER 2

Organization of the Study

2.1 The basis for the research

The aim of this study was to determine the future availability of land for residential purposes in the City of Rockhampton - defined as the Rockhampton Local Government Area (L.G.A.). This comprises the Parishes of Murchison, Archer and Rockhampton (figure 2.1).

In order to guage the area of land suitable for future residential sub division, it was necessary to incrementally subtract land unsuitable for such purposes. The residual area then became the land available for later residential development.

First the land in the L.G.A. was categorized as already zoned or at present unzoned. Zoned land that was already fully developed, and that zoned for non-residential purposes, was deleted from the study because it was not available for future residential development.

The remaining zoned land was either partly developed or undeveloped. The partly developed land was studied to determine the area of land unsuitable due to flood, drainage or erosion problems and then the number of remaining vacant residential allotments was calculated. The undeveloped land zoned for residential purposes was treated in the same way as unzoned land.

The unzoned land was subjected to field research to determine the area to be deleted from the study because its development would entail excessive costs. Four major constraints were identified as limiting residential sub divisions. These were:

i) excessive slopes,
ii) water supply problems,
iii) land with flooding, drainage or erosion problems or reclaimed land,
iv) unsewerable land.

This land was deducted from the area of undeveloped land so that the remainder was suitable for future residential sub division.

Second, it was necessary to calculate the number of allotments that could be obtained from the land found suitable for residential purposes. Thus space had to be deducted for services such as roads and verges and an allowance was made for land reserved for recreational purposes. The average size of allotments in recent sub division was used to calculate the number of allotments that could be sub divided from the vacant land. Where the land was already fully serviced a corrected number of allotments per hectare was used in this calculation.

It was then recognized that not all residential allotments are actually built upon. Some are held as investments or for retirement or remain in deceased estates. Therefore a 'normal' vacancy level was calculated and used to obtain the number of allotments that will remain vacant. The balance was the number of allotments available for future residential purposes.

This decision process is illustrated in figure 2.2.

Finally, a series of possible growth rates for the L.G.A. were calculated in order to determine the possible dates when the City of Rockhampton will run out of available residential land.

2.2 Format of the Report

The following chapter assesses the existing situation. It classifies the land available for all purposes in the Rockhampton L.G.A. and delimits the areas already zoned, the land at present in residential use, that partly developed and that undeveloped.

Chapter 4 then determines the area unsuitable for future residential purposes by virtue of its topography. The next chapter describes the location, size and present use of the remaining land suitable for future residential development. Chapter 6 then determines the area of land lost during residential sub division so that the probable number of future allotments can be calculated. The 'normal vacancy' rate is then calculated in Chapter 7 so that the number of occupied residential allotments can be estimated.

Finally, Chapter 8 determines when Rockhampton can be expected to run out of land suitable for residential purposes. This date is calculated on the basis of past growth rates, predicted growth rates, the maximum and minimum expected growth rate and a series of other possible growth rates. The results are presented graphically so that accurate predictions can be made when the actual growth rate is finally known.

FIGURE 2.1

THE ROCKHAMPTON L.G.A.

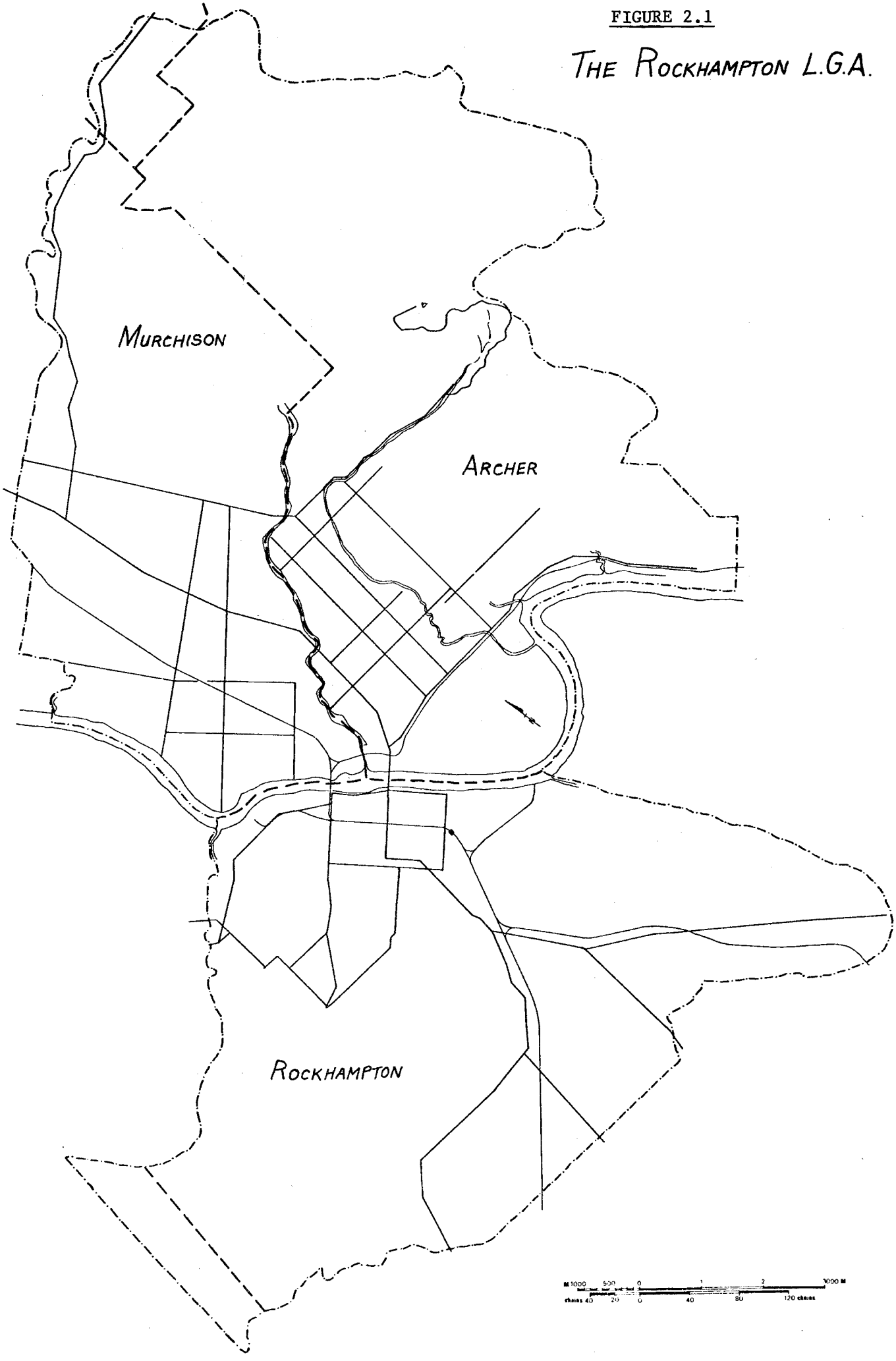
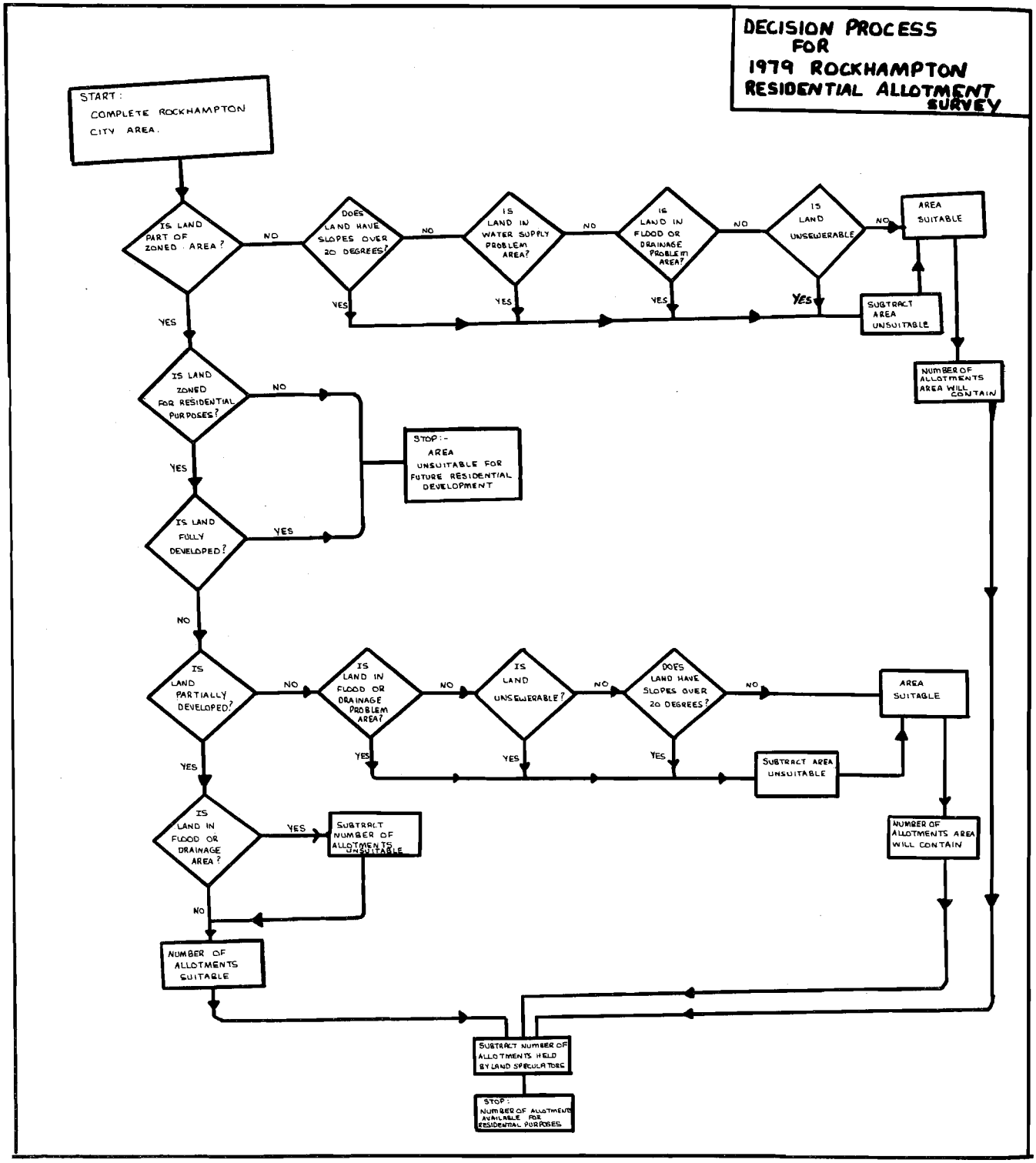


Figure 2.2


DECISION PROCESS FOR 1979 ROCKHAMPTON RESIDENTIAL ALLOTMENT SURVEY
START: COMPLETE ROCKHAMPTON CITY AREA.
IS LAND PART OF ZONED AREA?
NO
DOES LAND HAVE SLOPES OVER 20 DEGREES?
NO
IS LAND IN WATER SUPPLY PROBLEM AREA?
NO
IS LAND IN FLOOD OR DRAINAGE PROBLEM AREA?
NO
IS LAND UNSEWERABLE
NO
AREA SUITABLE
YES
YES
YES
YES
SUBTRACT AREA UNSUITABLE
YES
IS LAND ZONED FOR RESIDENTIAL PURPOSES?
NO
STOP:- AREA UNSUITABLE FOR FUTURE RESIDENTIAL DEVELOPMENT
YES
IS LAND FULLY DEVELOPED?
YES
NO
IS LAND PARTIALLY DEVELOPED?
NO
IS LAND IN FLOOD OR DRAINAGE PROBLEM AREA?
NO
IS LAND UNSEWERABLE?
NO
DOES LAND HAVE SLOPES OVER 20 DEGREES?
NO
AREA SUITABLE
YES
YES
YES
SUBTRACT AREA UNSUITABLE
YES
IS LAND IN FLOOD OR DRAINAGE AREA?
YES
SUBTRACT NUMBER OF ALLOTMENTS UNSUITABLE
NO
NUMBER OF ALLOTMENTS SUITABLE
NUMBER OF ALLOTMENTS AREA WILL CONTAIN
NUMBER OF ALLOTMENTS AREA WILL CONTAIN
SUBTRACT NUMBER OF ALLOTMENTS HELD BY LAND SPECULATORS
STOP: NUMBER OF ALLOTMENTS AVAILABLE FOR RESIDENTIAL PURPOSES

CHAPTER 3

THE EXISTING SITUATION

3.1 Introduction

The urban area of the local authority of Rockhampton is centred around the Fitzroy River. This positioning may be attributed to the settlement preferences expressed by the early pioneers. From this central position on the banks of the Fitzroy, settlement has spread outwards.

At first, most of this development occurred on the southside of the river. It was not until later that there was considerable development on the northside. Today, the majority of growth is occurring on the northside. This can be attributed to two factors:-

1. Availability of land in North Rockhampton.
2. Lack of suitable land in South Rockhampton.

This lack of suitable land in South Rockhampton can be attributed to the following:-

1. Flood prone areas in Depot Hill and to the South.
2. The lagoons in the south-west.
3. The Airport in the west.

The barriers to development in North Rockhampton are:-

1. The Commonage in the south.
2. The Berserker Range.

The development on top of Mt. Archer could be seen as a forerunner to future developments on the slopes of Mt. Archer.

The following sections will look at the land that has been zoned for present residential use, future residential use and the degree of development within the residential zonings. The area outside the present zonings will also be examined.

Table 3.1

Composition of City of Rockhampton by Zoning and Degree of Development

Total Area	% of Total Area	% of Zoned Area	% of all Residential
Unzoned	68.5		
Zoned	31.5		
Residential	16.1	51.0	
Future Residential	1.7	5.5	
Fully Developed	10.5	33.4	59.0
Partially Developed	1.4	4.4	7.8
Undeveloped	5.9	18.7	33.2

Source: Fieldwork

Table 3.2

Composition of City of Rockhampton by Zoning and Degree of Development (ha)

Total Area	16,100 ha
Unzoned	11,030 ha
Zoned	5,070 ha
Residential	2,589 ha
Future Residential	279 ha
Fully Developed	1,691
Partially Developed	226
Undeveloped	952

Source: Fieldwork

3.2 Present Residential

Rationale

City Councils must have a great amount of foresight when they plan a city. They must plan the locations of the various types of activities so that they complement each other. An important decision which they must make concerns the amount of land which they make available for residential purposes.

The aim of this component of the study was to delimit the areas that are zoned present residential.

Methodology

The areas that are zoned for present residential purposes were delimited by using the following procedure:-

(a) Consulting the Rockhampton Town Plan maps for areas zoned residential.

(b) For each average sized city block the following decision process was used:-

Table 3.3

Decision Table

Possible Tests	Possible Conditions				
1. All block residential	Yes	No	No	No	No
2. Separate blocks other uses	No	Yes	Yes	No	No
3. Clusters of blocks other uses	No	Yes	No	Yes	No
Action Descriptions	**Actions Performed**				
1. All block residential	✓		✓		
2. Other Use blocks not included			✓	✓	
3. Complete Block Excluded		✓			✓

Results

The following figures are obtained from Tables 3.1 and 3.2:-

City of Rockhampton (Total Area) - 16100 hectares
Total Zoned Area 5070 hectares
representing 31.5% of total area
Zoned Present Residential 2589 hectares
representing 51% of total zoned areas

3.3 Future Residential

Rationale

Much of the same situation exists when a City Council has to decide which areas are to be zoned for future residential purposes. They must decide when a particular area will become needed by the public. This timing is regulated by using Council regulations.

Methodology

The areas classified as future residential have been delimited by using the Rockhampton Town Plan. The zones which constitute future residential are:-

Future Urban A
Future Urban B

These areas were then mapped, they are shown on Figure 3.2, and the area of these areas was calculated.

Results

In Rockhampton there are two main areas that are zoned for Future Residential purposes. They are:-

1. East of Norman Road
2. Nerimbera

From Tables 3.1 and 3.2, the total area of land that is zoned for future residential purposes is 279 hectares which represents 5.5% of the total zoned area.

3.4. Areas Presently Developed

Rationale

When a city is developing, the direction and intensity of development can occur in a number of ways. Some of these are:-

1. Circular Growth from City centre (this may occur when the region has a uniform plain on which to develop)

2. Corridor Development (this type of growth occurring along major arteries of traffic movement)

3. Satellite Development (this occurring when development leap-frogs over another potential area of development)

The type of development that occurs can be dictated by either local government administration policy or the physical characteristics of the region.

Methodology

The delimitation of areas according to their development status was undertaken by studying air photographs of Rockhampton. On average, these photographs were approximately three years old, and because of this time lag, corrections were made to area boundaries during the fieldwork. This then accounted for any new development that had taken place since the photographs were taken.

The area was divided up into the following status areas:-

Table 3.4

Status Table for Residential Areas

Status	Criteria for Status Assignment
Fully developed	85% - 100% of available land occupied
Partially developed	15% - 85% of available land occupied
Un-developed	0% - 15% of available land occupied

Results

Figure 3.3 shows that all the residential area that is available close to the city centre has been developed.

There are also a number of new development areas which have been partially developed. They are:-

Oasis Gardens
Dixon Heights
Duthie Heights
Church Estate (near Drive-In)
Diggers Park
Santina Estate
Mountain Village Estate

The major undeveloped regions occur on both sides of Norman Road and on both sides of Thozet's Road. A substantial portion of the Norman Road region is zoned for future residential purposes, thus most of the other regions will come on-line before Norman Road.

From Tables 3.1 and 3.2 the following figures were obtained:-

City of Rockhampton (Total Area)	16,100 hectares
Zoned for Residential purposes	2,868 hectares
which represents	17.8% of Total Area

Within this area zoned for Residential purposes the following percentages of areas developed occurred:-

Fully Developed	59.0% of Zoned Residential
Partially Developed	7.8% of Zoned Residential
Undeveloped	33.2% of Zoned Residential

3.5. Unzoned Area

Rationale

Leaving an area unzoned may indicate one of two possibilities. Either the land is unsuitable for city development, or the land is being held, uncommitted, until a need arises for that land. When the land is needed then a Council can zone it according to their needs, if the land is suitable.

Methodology

The area that remains unzoned within the Rockhampton City Limits was delimited by marking the zoned extremities onto a map. This area is shown on Figure 3.1.

Results

The unzoned portion of the City of Rockhampton occupies approximately 11,030 hectares which represents 68.5% of the total area. Approximately half this area is occupied by mountains and lagoons.

In North Rockhampton, the zonings cease at the base of the Berserker Range. The land to the east of this is mountainous and undulating. In South Rockhampton, the zonings extend up to the edge of the lagoons. Much of the area on the other side of the lagoons is subject to flooding.

Figure 3.1

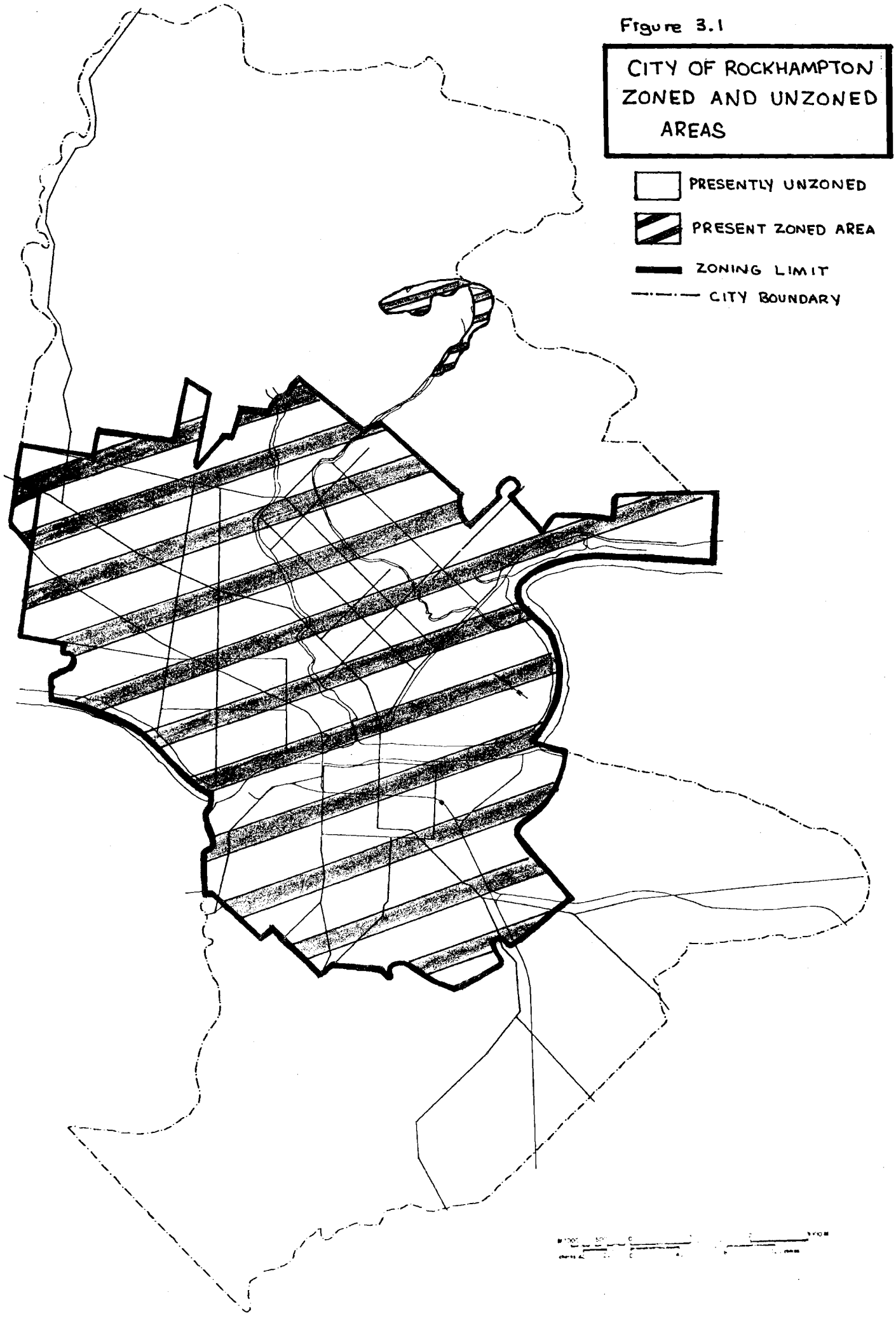

CITY OF ROCKHAMPTON
ZONED AND UNZONED
AREAS
PRESENTLY UNZONED
PRESENT ZONED AREA
ZONING LIMIT
CITY BOUNDARY

Figure 3.2

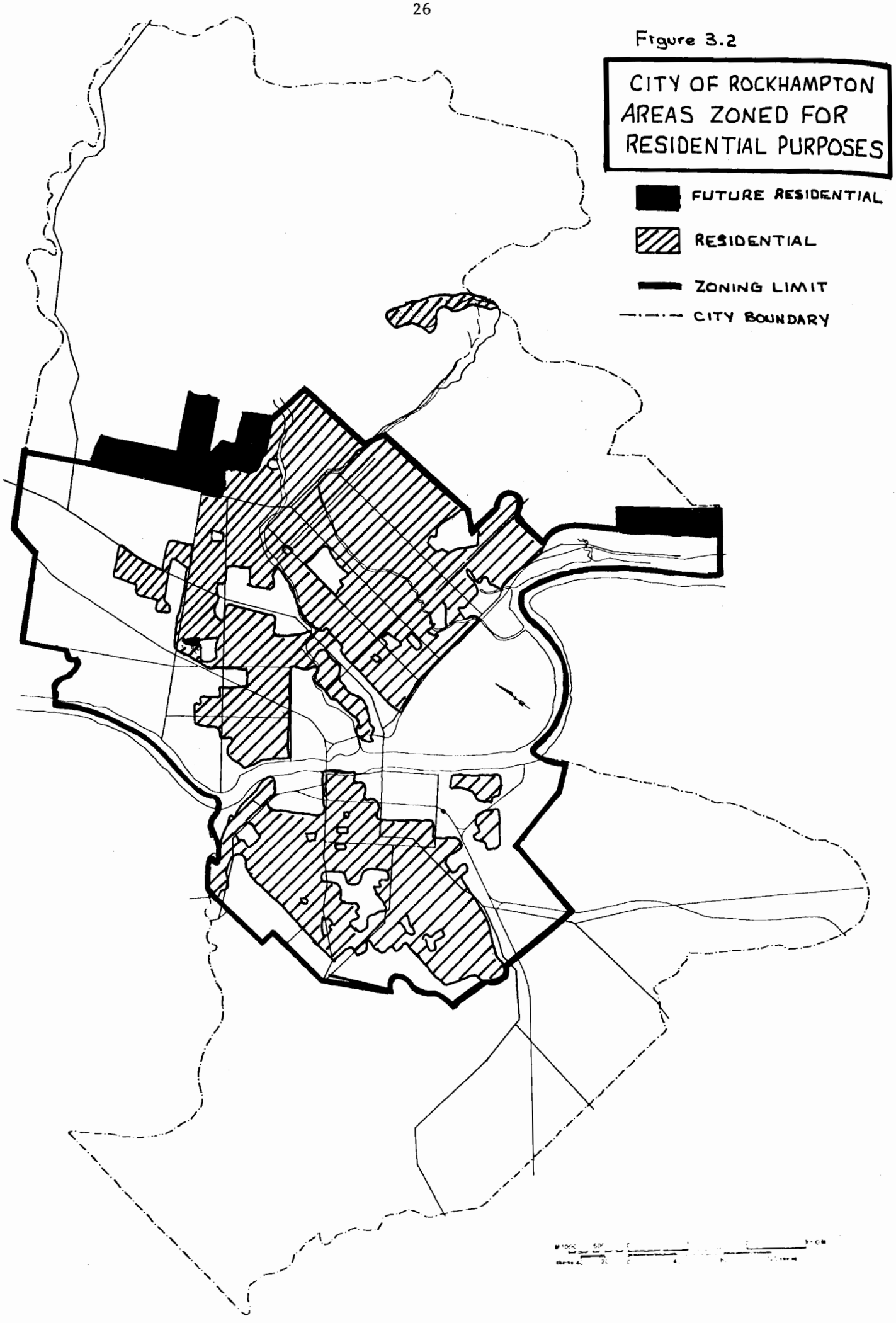
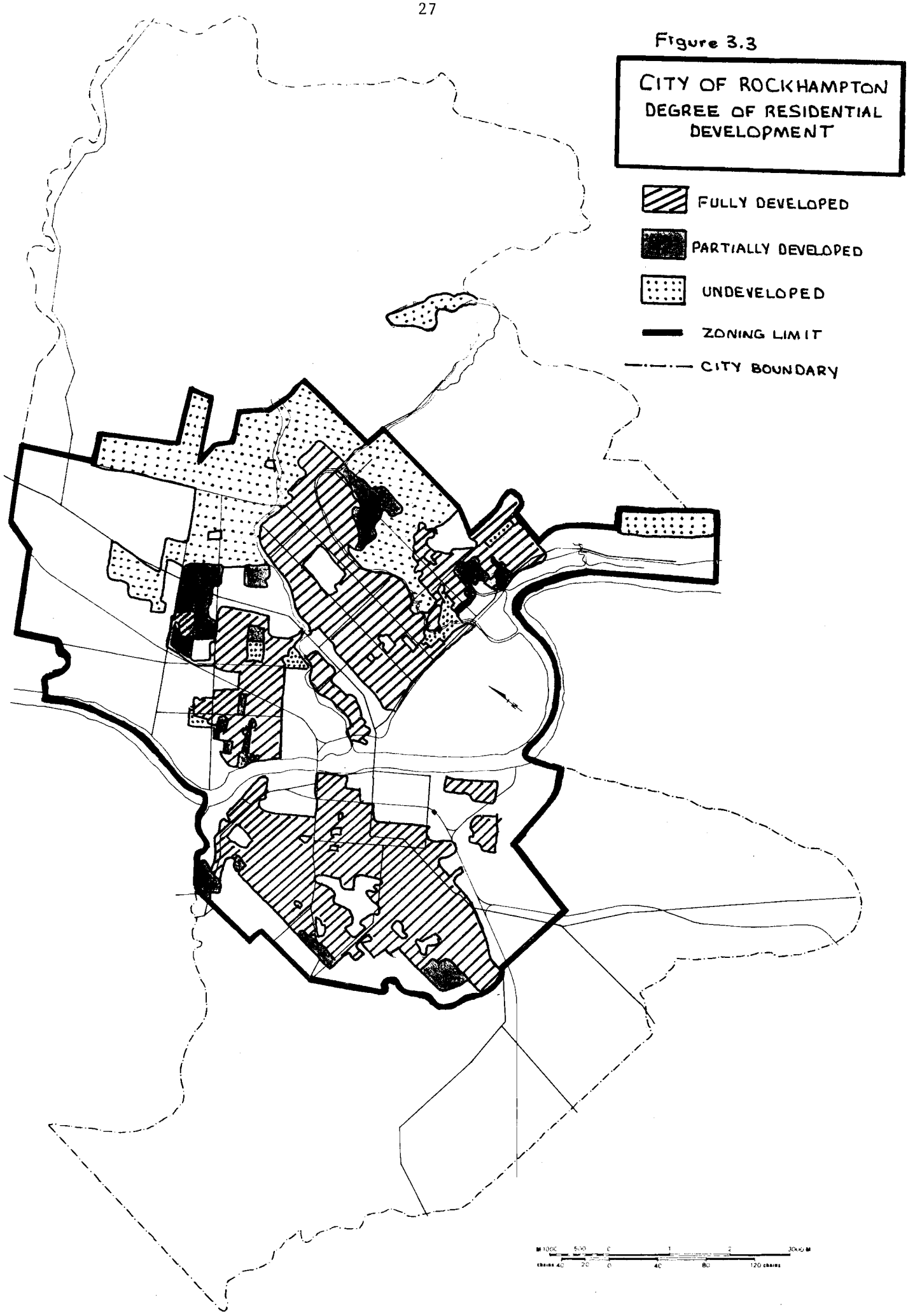

CITY OF ROCKHAMPTON
AREAS ZONED FOR
RESIDENTIAL PURPOSES
FUTURE RESIDENTIAL
RESIDENTIAL
ZONING LIMIT
CITY BOUNDARY

Figure 3.3


CITY OF ROCKHAMPTON
DEGREE OF RESIDENTIAL DEVELOPMENT
FULLY DEVELOPED
PARTIALLY DEVELOPED
UNDEVELOPED
ZONING LIMIT
CITY BOUNDARY

CHAPTER 4.

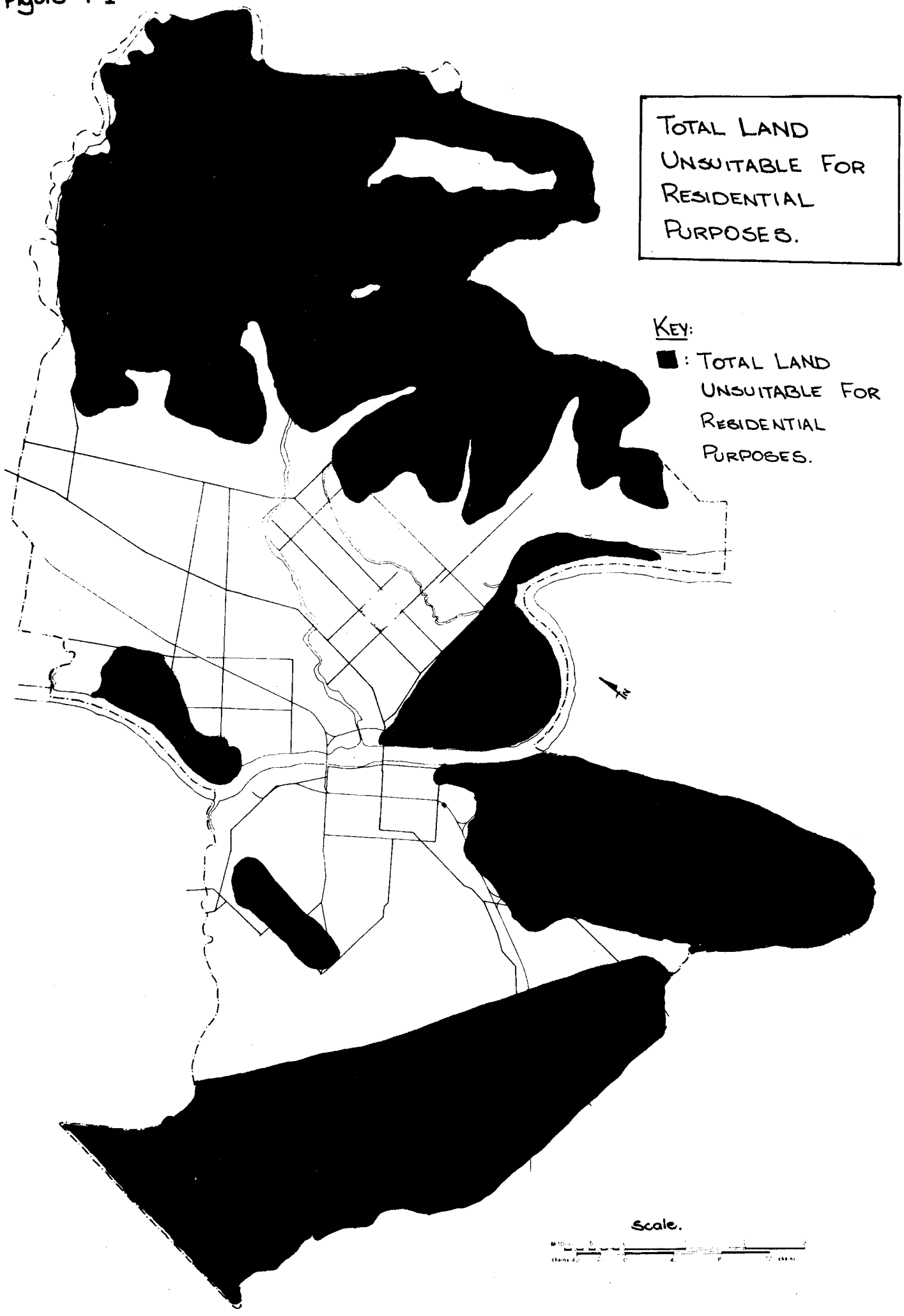
Delimitation of Areas Unsuitable for Residential Purposes

This report has taken the approach that land with above normal costs of subdivision would be excluded from the study. When additional costs are incurred to the subdivider, many other considerations must be taken into account that are outside the realm of this study.

A number of possible causes of increased development costs have been identified and researched. These were recognised as water supply and sewerage problems, and difficulties encountered due to slope. In addition, land unsuitable for residential purposes because it was flood prone or reclaimed was also excluded from the studies.

Each of these problems is individually discussed in this chapter. All sections follow the general format of establishing the rationale for excluding and delimiting certain areas, the methodology adopted and the results. Appropriate maps are included to indicate the areas unsuitable for residential purposes. The areas illustrated on these maps were subtracted from the total survey area, so that only areas suitable for residential purposes were studied in the field.

Figure 4·1



SOURCE: FIELD SURVEYS.

4.1 Flood Prone Land and Reclaimed Land

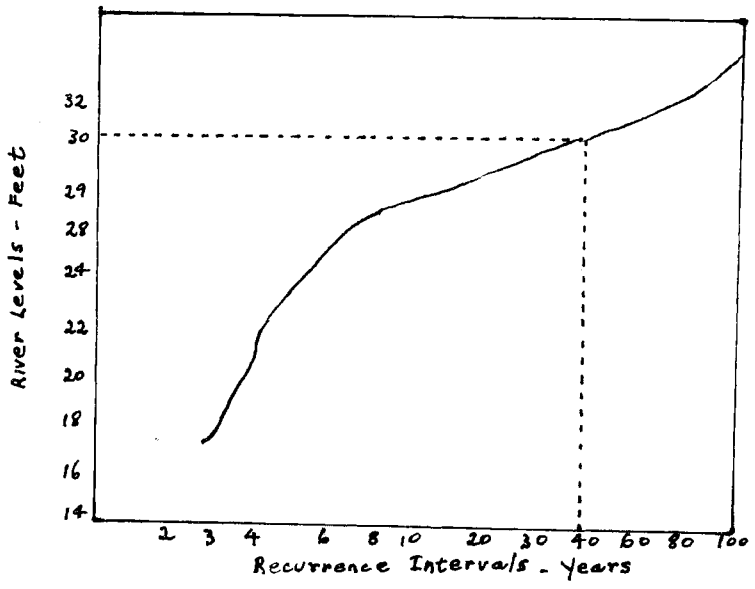
Flood Prone Land

The highest flood experienced in the Fitzroy River occurred in 1918 when the flood water rose to a height of 32 feet 11 inches. One of the main features of the topography of Rockhampton is that the overflow section of the flood plain around the town is so pronounced that even considerably higher floods would not exceed the level of the 1918 flood by more than a few feet.

Much of the land in the Rockhampton area is often inundated in flood times. To protect home owners and potential home owners, the Rockhampton City Council has imposed a restriction on land that was covered by more than two feet of water in 1954 flood. Construction of dwellings on land in these areas is prohibited and present dwellings are prevented from being rebuilt. This policy applies to residential purposes only, as warehouses and industries can build on those areas so long as a two feet high concrete floor is laid.

The height of the 1954 flood was 30 feet 4 inches and this level can be expected to be equalled or exceeded once in every 40 years. The following graph illustrates the different flood levels compared to their expected recurrence intervals.

Figure 4.2 Probabilities of Flood



Source: Queensland Division of Engineers Technical Papers Vol. 8 Nov. 1967 No. 8 'Design of the Fitzroy River Barrage' page 10

The Department of Engineering in the Rockhampton City Council has in its possession maps showing land that lies in the restricted areas. These were reproduced onto overlays at a scale of 1 inch to 8 chains. The information from these was transferred on the smaller scale parish maps of 1 inch to 40 chains.

The city limits was the boundary of the study area and the council has not researched those areas as yet unzoned, such as Yeppen and the area west of the aerodrome. It was therefore necessary to carry out research to establish which of these areas are flood prone.

To accomplish this an overlay was taken of the aerial photographs of the 1954 flood and the 1978 flood. As the height of the 1954 flood was 30 feet 4 inches and the height of the 1978 flood was 26 feet 3.3/4 inches, by taking the mid-point a rough estimate of the two feet level of the 1954 flood could be established.

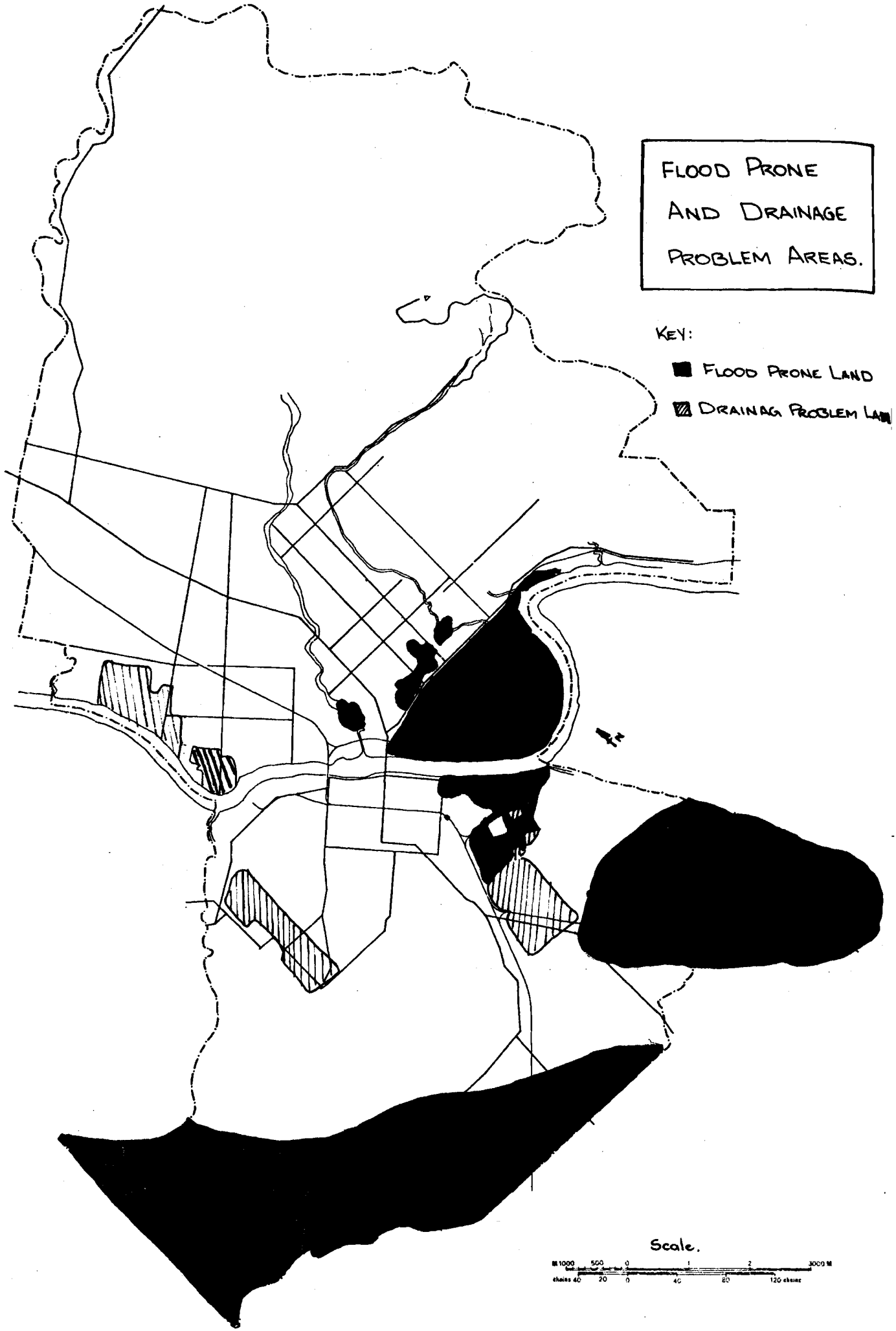
Figure 4.3 shows the resultant areas that are restricted by the council because of susceptibility to being flooded, and those areas that were found unsuitable by the use of aerial photographs.

Drainage Problem Areas

When considering flood prone areas it is also necessary to recognise land that has a drainage problem such as that which is affected by flash-flooding or ponding after heavy rain falls. It is usually so low lying that the water collected will not run off and it is expensive to rectify this problem.

In these areas, the same restrictions and prohibitions apply as with flood prone areas. In some cases the drainage problem areas overlap with that of flood prone land however there are other instances where this is not so. Figure 4.3 illustrates those areas that are designated as a drainage problem area. At present research is being undertaken by the City Council in the Lakes Creek area to decide whether it is a drainage problem area or not. As yet this has not

FIGURE 4·3



SOURCE: ROCKHAMPTON CITY COUNCIL MAPS AND FIELD RESEARCH.

been decided. Other areas with obvious drainage problems, including lakes, marshes and swamp land were also excluded from this study.

Reclaimed Land

The Council abides by a policy that states that reclaimed land cannot be built on for residential purposes, and only in special circumstances for other uses. The main reason for the prohibition of building on reclaimed land is because of subsidence due to lack of adequate foundations. Reclaimed land is zoned for parks and recreation and therefore no distinction can be made between land set aside for parks and recreation and that which has been reclaimed. These, however, were also deducted from the survey area.

4.2 Areas with Water Supply Problems

Rationale for Delimination

Rockhampton today is in a rather fortunate position. Over the past decades the Council has been able to meet the demand for water exerted by Rockhampton's increasing population. A short drive around Rockhampton will reveal a high incidence of building activity in the northern suburbs. The city has been forced to grow in this direction because vacant land to the south and west of the city is prone to flooding. This land is therefore not suitable for home sites. The high concentration of commercial and industrial activity south of the Fitzroy River, coupled with the fact that most vacant land has been utilized in these southern and western areas has resulted in people looking elsewhere to build their homes. They have chosen the northern and eastern areas of Rockhampton, in particular areas such as Kawana, Oasis Gardens, and the Berserker Ranges/Frenchville area.

Accompanying this growth, the Rockhampton City Council has constructed several reservoirs to supply water with an adequate pressure for these developments. The various statistics for these reservoirs are shown in Table 4.1:

Table 4.1

The Capacity and Heights of Rockhampton Reservoirs (1979)

Name of Reservoir	Capacity ('000 litres)	Height above Sea level (metres)
Athelstane Range Reservoirs (3)	18,160	89
North Rockhampton	9,080	91
Yaamba Road	13,620	97
Mt. Charlton	9,080	119
Kerrigan Street	4,540	150

Source: Rockhampton City Council Water Department

All of these reservoirs, except the Kerrigan Street Reservoir are considered by the Council as supplying houses connected to 'low level' reticulation.

Before the construction of the Kerrigan Street Reservoir, homes on 'low level' reticulation invariably received poor supply in periods of heavy demand. The Council realised this and also the fact that Rockhampton was going to grow towards the east, beyond the low level reticulation mark. Thus, to allow growth to proceed, the Kerrigan Street Reservoir was constructed. This increased the quality of water supply (pressure especially), and the amount of land that could be used for home sites. Having a height about sea level of 150 metres, this reservoir is designed to serve homes between the low level reticulation system and a height of 150 metres above sea level.

Without any further expenditure on new reservoirs the amount of land left for development of urban areas appears rather limited, especially when figures on Rockhampton's population growth are considered. As an alternative to building a costly reservoir in the very near future, the Council has established a 227,000 litre tank on the top of Mt. Archer. The construction of this tank, the costly piping and continual pumping needed to keep this tank full are reflected firstly in the high price of the land, and secondly, in the consumers' rate bills.

Thus if money was not an important factor, reservoirs could be built at sufficiently high points to service the entire area of Rockhampton. Such expenditure may be beyond the means to Rockhampton City Council. In areas above the height of the Kerrigan Street Reservoir water would have to be pumped. Small booster pumps are relatively inexpensive, but the higher the home site is from the Kerrigan Street Reservoir, the higher the costs of pumping become. Most home owners are unwilling to pay this additional pumping cost and so they prefer land supplied by the natural fall from the reservoir. In the case of Kerrigan Street Reservoir this is areas below 150 metres.

Methodology

Rockhampton City Council sources state that the area south of the Fitzroy River has an adequate supply of water. There is, however, an exception to this. It is the Range Convent, and water for this block has to be pumped to establish and maintain adequate pressure. This pumping has undoubtedly increased the cost of water for this block, but, apparently the cost has not been all that great. Otherwise, the school

would have relocated to a lower block where water is more readily available.

The capacities of the reservoirs situated on the south-side may seem as though they are not being fully utilized. This can best be explained by the fact that these reservoirs are situated on the Athelstane Range and have to supply a considerable amount of Rockhampton's light industries as well as the C.B.D., several large schools and the Hospital. Therefore it can be concluded that the area to the south of the Fitzroy River does not have any major problems with water supply. The problem area is to be found on the north-side of the river and is associated with the Kerrigan Street high level reticulation reservoir.

To determine this problem area two "cut-off" points are needed. The first one is 96 metres. This figure was arrived at by the Rockhampton City Council and signifies the areas which have to be served by high level reticulation. The second important "cut-off" is the height of the Kerrigan Street Reservoir (150 metres) which represents the height to which water can be supplied by high level reticulation without incurring the cost of additional pumping.

By continuously pumping water from the Barrage (height 23 metres above sea level) the Council aims to keep its reservoirs at near maximum capacity. They have calculated, as a maximum figure, that each household will consume approximately 5,248 litres (1,200 gallons) per day. At the present time Council figures indicate that 357 households were connected to high level reticulation supplies coming from the Kerrigan Street Reservoir which was designed to meet the requirements of 1755 households. Further figures on the calculation of the area of land that can be supplied with water from this Reservoir are seen on Table 4.2.

Assuming that 8.4% of these allotments will remain vacant due to speculation,* the 1398 blocks calculated on Table 4.2 will be reduced by this margin to 1281 households. The equivalent area of land can be seen on Figure 4.4. Census statistics for Rockhampton reveal an average of 3.21 persons per allotment and thus the total number of people required to fully utilize the reserves of the Kerrigan Street Reservoir will be 4,112 (1281 multiplied by 3.21).

Results

Figure 4.4 shows the two contour lines of 96 metres and 150 metres. They represent the upper limits of low level reticulation and high level

reticulation. The additional area that can be supplied from the Kerrigan Street Reservoir's excess capacity is shown. This amounts to 127.09 hectares. **

This shows that Rockhampton is in a fortunate position as far as adequate supplies of water are concerned. It is anticipated by the Council that in view of future growth, and the exhaustion of the Kerrigan Street Reservoir's supplies, a new reservoir will be built on Kent Hill, due east of the site of the C.I.A.E.

* Figure calculated by Field Work Survey.

** With there being 11 blocks to the hectare (this figure includes land left for roads and recreational purposes) the reservoir can be expected to supply an area of 127.09 hectares (1398 households divided by 11 - the number of household blocks per hectare).

Table 4.2

Data for the High Level Reticulation Kerrigan Street Reservoir

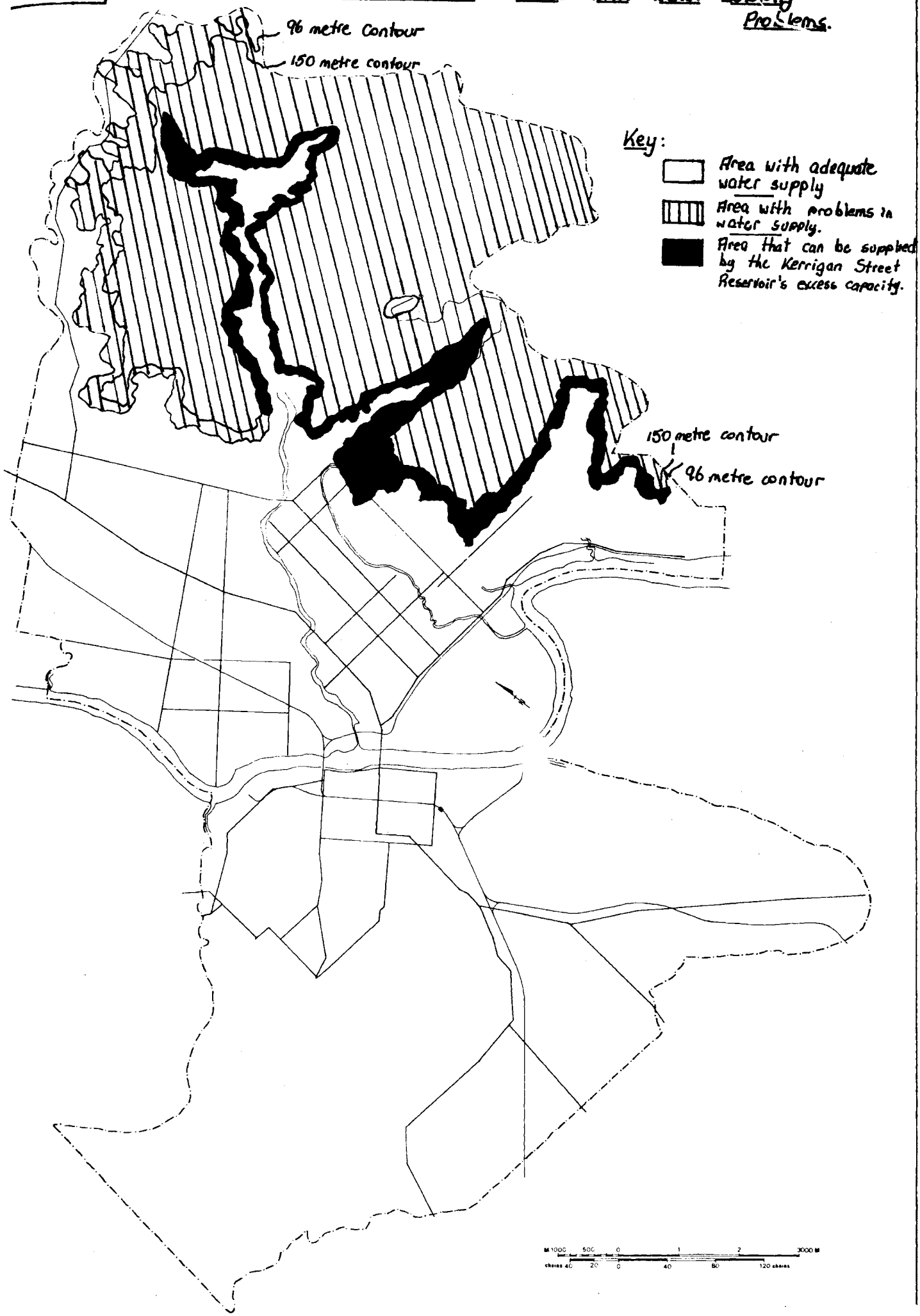
Number of Households consuming from the Kerrigan Street Reservoir	357
Maximum number of households that can be supplied by Kerrigan Street Reservoir	1755
Number of households that in future the Kerrigan Street Reservoir can supply	1398

* Average size of an allotment: 600 sq. metres.

Source: Field Work Survey and Council Statistics.

FIGURE 4.4

ROCKHAMPTON SHIRE: Areas with Water Supply Problems.



Source: Field Research and Council Statistics.

4.3 Areas with Sewerage Problems

A sewerage system, in today's society, is a vital public utility. As such, any land which fails to fulfill the requirements as laid down by practical and legal viewpoints, of land that can be sewered will not be able to satisfy society's requirements. This being "a system of sewers and ancillary works to convey sewerage from its point of origin to a treatment works or other place of disposal" (Public Health Engineering - Design in Metric: 'Sewerage', p.2). With today's high level of hygiene and high standard of living, few people, if any, would want to live on residential land if it were unable to be supplied with a suitable system of waste removal.

Sewers are usually laid in straight lines. Manholes are used at any change of direction, gradient or diameter of pipeline. These manholes, when used on public land are spaced no more than 90 metres apart.

To protect them from damage, sewers are usually laid with at least 1200 millimetres of soil from roadway to the top of the sewerage pipe. To avoid interference with private property when carrying out maintenance actions, most sewers are laid under roads. When not under a road, the pipes should be within at least 900 millimetres from the surface. The pipes should not be unnecessarily deep, but deep enough to pick up all drain connections.

Rockhampton's sewerage system is largely dependent on gravity for the flow of wastes. The topography of the area to be sewered obviously affects the layout of the sewerage system. The location and the level of the treatment works, or other place of disposal is therefore basic to the design of the system.

However, it is impossible for each area to have a waste removal system operated solely by gravity. Therefore the sewerage is gravitated to the lowest point in the area served and then elevated by a pumping process to a level at elevation required to allow it to proceed on its journey to gravitation.

Sewers are designed not only to accommodate the estimated flows, but also to ensure a minimum flow velocity of 45 metres per minute when the sewer is full. Sewerage pipes should also be laid with a gradient sufficient to prevent silting but not so steep as to produce scouring.

There are maximum and minimum slopes to enable this to be put into

practice. If the slope of the land is steeper than the maximum permissable grade of the sewer the problem may be overcome by introducing; 'drops' or 'steps' in the sewer lines. The minimum grade of a sewer main is based on the minimum self-cleansing velocity which is generally accepted as being between two and three feet per second.

Because of the longevity of sewers and similar works it is essential that any design of a sewerage system be based on the probable future population densities. It is generally accepted to work on an estimated population for the next 25 years.

The layout of reticulated sewers will also be influenced by local regulations regarding connections of house drains and sewers. Often it is a rule that each house drain must be separately connected to the sewer. However, in Rockhampton it is permitted for a series of house drains to have a common connection with the sewers. This can mean a substantial reduction in cost.

Streets that rise and fall along their length are not favourable for economic draining. Either the sewer will need to be placed at a considerable depth under the high levels or a special outlet will be needed at each low level. This can be very expensive.

The primary restriction of land which is able to be sewered is elevation in comparison with the treatment plant. Any land lower than the treatment plant will not be sewered due to the high cost of pumping and the liability of submergence in time of flood. The treatment plant is 23 metres above sea level. Land lower than this cannot be sewered. The maximum height of land to be sewered is also important. Theoretically there is no limit to the height of land that can be sewered, however the cost may be a strong deterrent. Land more than 15 metres above the treatment plant becomes very expensive to sewer.

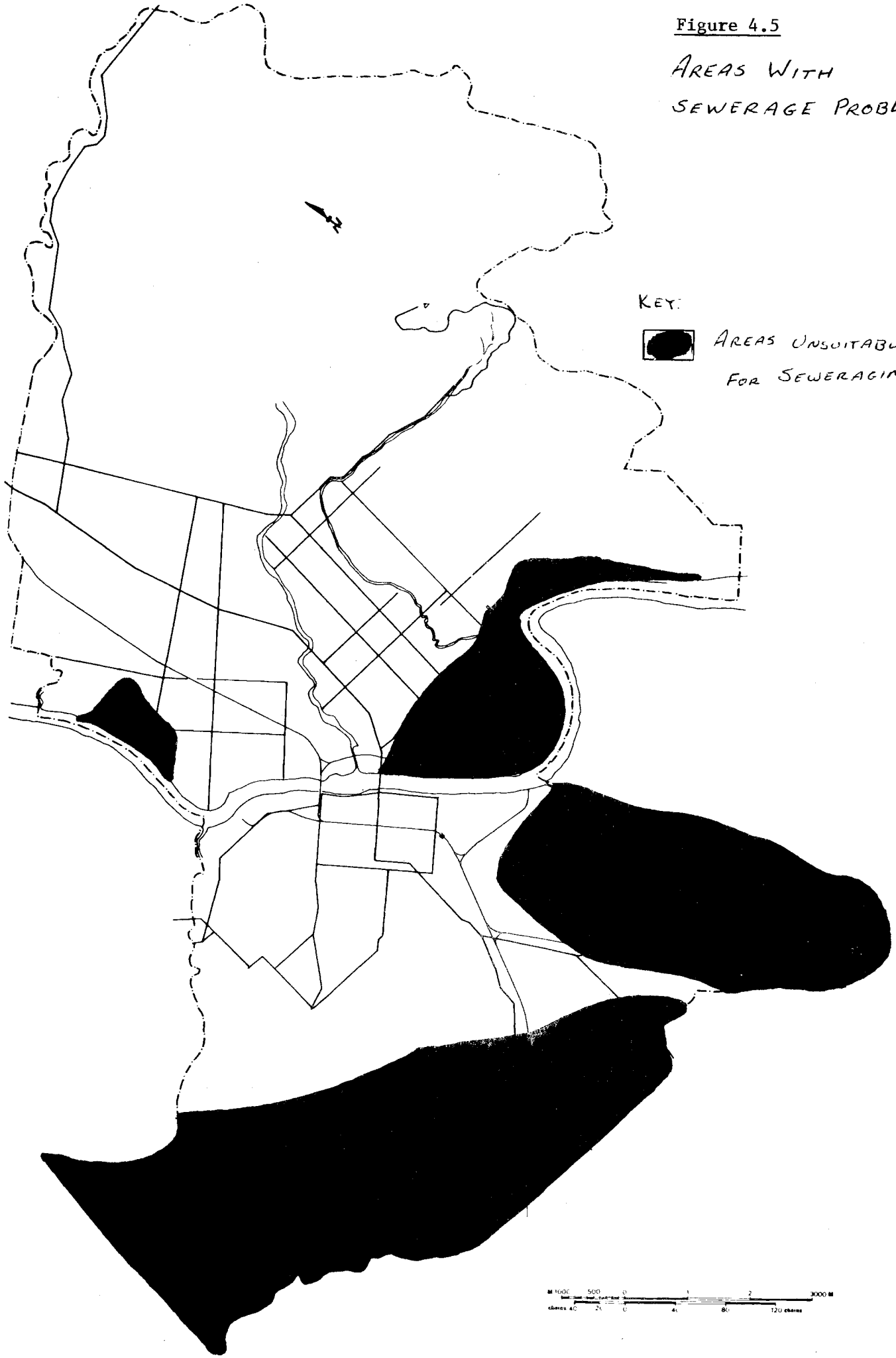
To determine areas unsuitable for residential purposes due to sewerage problems, with the treatment plant 23 metres above sea level, was a matter of excluding land lower than this. The areas that are unable to be sewered are also part of those areas that frequently flood with heavy rainfall. The largest area that cannot be sewered is the region furthest west; the areas surrounding Yeppen and Murray Lagoons. To the south of Rockhampton is another area with sewerage restrictions, the areas of Port Curtis and Depot Hill. The regions on the northside of Rockhampton that cannot be sewered include the area known as'the Commonage' and an area along Lakes Creek Road. There is also a small

area opposite the ski gardens.

As a result of the various restrictions to seweraging land, it has been determined that, out of the total of all land in Rockhampton that is suitable for residential purposes in the future, 963 hectares of land is unsuitable for residential use because it could not be sewered (Figure 4.5).

Figure 4.5

AREAS WITH SEWERAGE PROBLEMS



4.4 Areas with Difficulties due to Slope

The discussion throughout this paper pertains to the measurement of average slope. This refers to the angle of slope average measured in degrees. Slope is another attribute which can make an area of land suitable or unsuitable for development.

The slope of the land can affect the costs for development and construction. Such costs are more expensive on a sloping surface as more constructional engineering is required.

The geology is an important factor relating to slope. If the substratum and top soil are not stable enough, building will not be able to take place or, a more expensive reinforced foundation may be called for.

The Method of Delimiting Areas which are Unsuitable Due to Slope

The angle of slope which was determined to be too steep for residential development because of increased costs was twenty degrees. This angle was determined from the cost to excavate an average block of land so that it would be level.

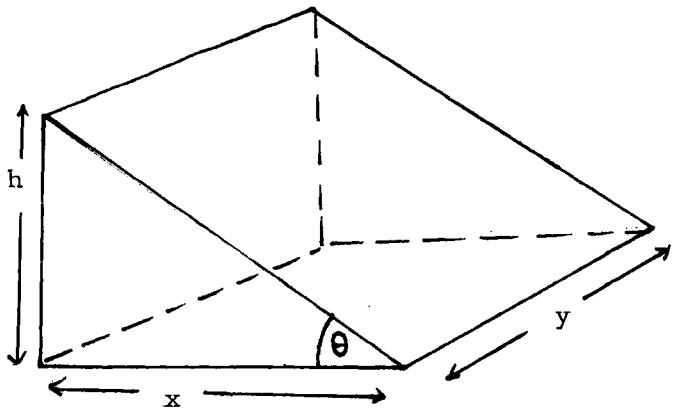
The dimensions of the block of land were taken from a map of the city subdivisions where a regular shape block of land used for residential purposes consistently appeared. The dimensions were:

Length	50.292 metres
Frontage or width	10.177 metres

From this the height of land was found if it was at a particular angle. Figure 4.6 shows these dimensions.

Figure 4.6

The Dimensions from which Equations and Calculations may be Formulated



Calculations and Equations Used in Determining the Slopes which were Unsuitable

The equation used to calculate the height was:

$$x \tan\theta = h$$

where: x = length of the allotment

h = the height of the land

$\tan\theta$ = a predetermined angle measurement

Once height was calculated for each angle, the volume of soil which would need to be removed for each angle measurement was found. The equation used to determine this was:

$$\text{Volume} = 1/2.\ x.\ y.\ h$$

The cost for carrying out this process was calculated from Cordells Building Cost Book for December, January, February 1979. At this point it is essential to note that the cost quoted is for soil. These costs may escalate due to other material such as rock, clay or sandstone being present. All these results have been tabulated in Table 4.2.

Once all these calculations were carried out the results of cost per angle were plotted on a graph. From this graph a point was determined for when the costs to excavate the land became excessive. The point was twenty degrees (20^{o}). Before this angle, costs are relatively constant to the increase in the angle. At the twenty degree angle the costs increase more rapidly (Figure 4.7).

From these calculations the area which was to be classed unsuitable due to slope was then determined. The following procedure was carried out.

The Area which was Considered too Steep

A one to one hundred thousand scale map of Rockhampton area was selected. This map had contour lines for height. With the use of a template, calculations were made and areas of over twenty degrees were recognized by the closeness of the contour lines.

These areas were mapped out on to a parish map at a scale of inch to eight chains map. These areas were then checked in the field using a clinometer.

The unsuitable areas revealed by the map known as the Berserker Range of which Mt. Archer is the highest point are north-east of the city. (Figure 4.8).

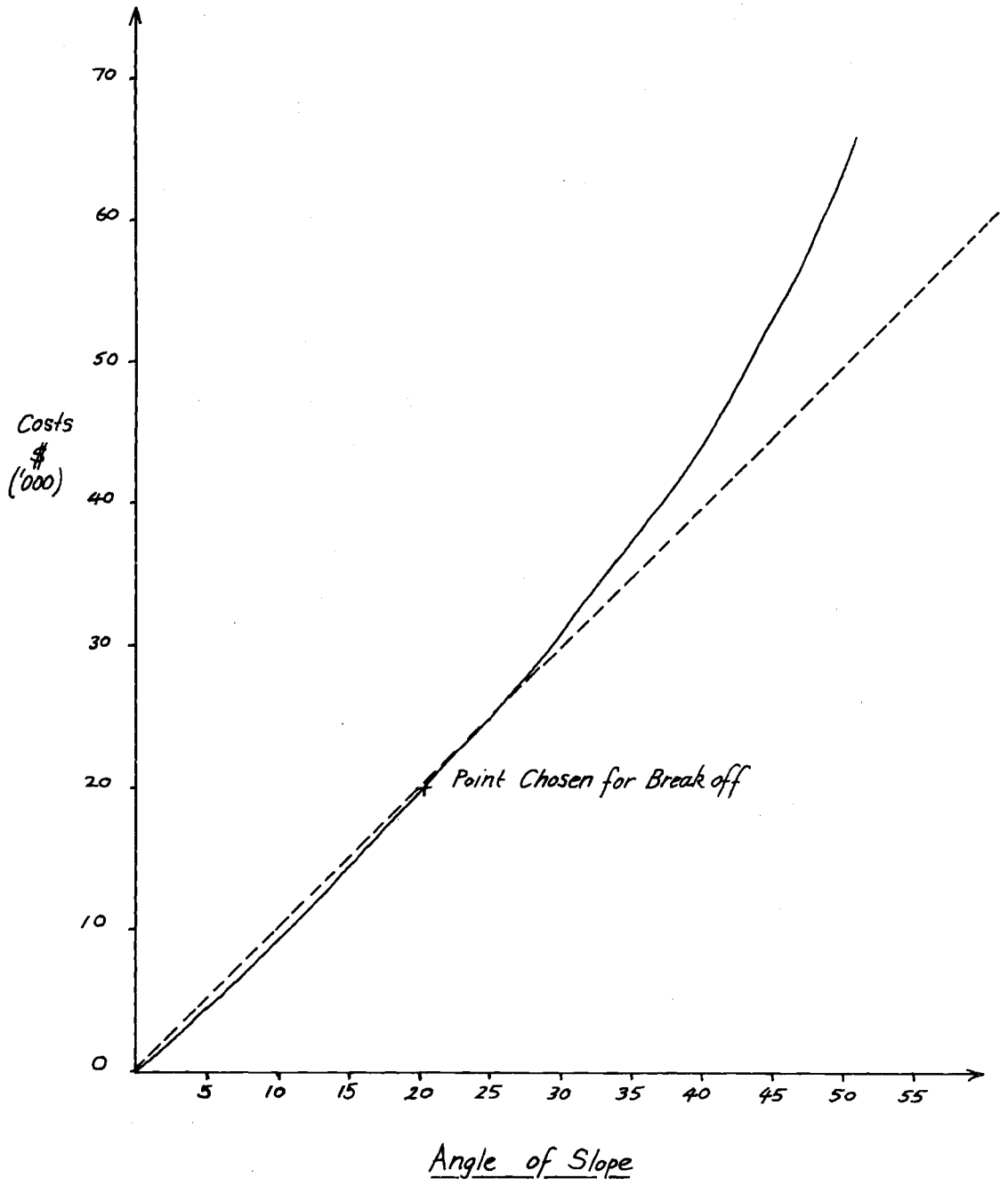
TABLE 4.2

Calculations for Costs of Excavation

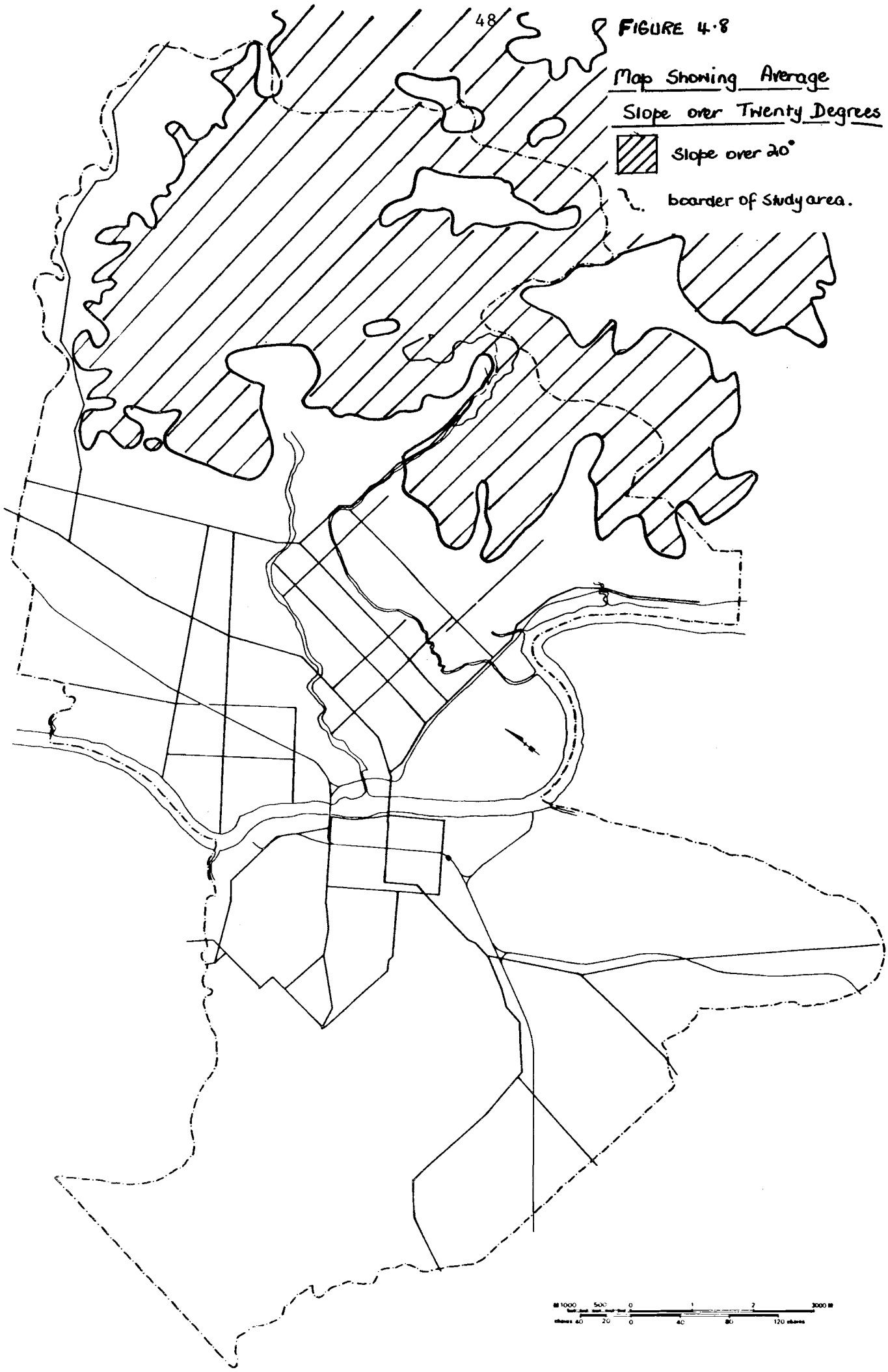
ANGLE OF SLOPE (°)	TAN OF ANGLE	LENGTH x metres	WIDTH y metres	HEIGHT h metres	VOLUME cubic metres	COSTS / CUBIC metre ($)	TOTAL COSTS ($)
5	0·0875	50·292	10·177	4·40	2226·48	2·10	4,651
10	0·1763	50·292	10·177	8·87	4486·60	2·10	9,421
15	0·2679	50·292	10·177	13·47	6816·06	2·10	14,313
20	0·3640	50·292	10·177	18·31	9263·31	2·10	19,452
25	0·4663	50·292	10·177	23·45	11866·21	2·10	24,918
30	0·5774	50·292	10·177	29·39	14872·16	2·10	31,231
35	0·7002	50·292	10·177	35·21	17816·89	2·10	37,415
40	0·8391	50·292	10·177	42·20	21353·74	2·10	44,842
45	1·000	50·292	10·177	50·29	25447·65	2·10	53,440
50	1·1918	50·292	10·177	59·94	30329·71	2·10	63,692

Source : Based on Mathematical Calculations and Costs from Cordells Building Cost Book

Figure 4.7
Graph depicting excavation costs in relation to average slope.



Source: Graphed from TABLE 4.2.



Source : Adapted from Livingood Map of Rockhampton

Chapter 5

Description of Land Suitable for Residential Purposes

This chapter involves four sections, one describes the area and location of land suitable for residential purposes, two discusses the area by zoning, three identifies the proportion of land already subdivided and vacant and areas unsubdivided and finally the present use of land suitable for future residential purposes will be discussed.

5.1 Area and Location of Future Residential Land

Figure 5.1 shows the total area of land suitable for future residential purposes in Rockhampton, which totals 1,176.9 hectares. South Rockhampton possesses 141.1 hectares or 12% of available future residential land in Rockhampton. North Rockhampton possesses 1,035.8 hectares equivalent to 88% of available future residential land. This demonstrates that the major area for future residential expansion is the north side of Rockhampton as it has 7.34 times the area of south Rockhampton available for future residential purposes.

5.2 Area of Future Residential Land by Zoning

Areas Zoned Residential

Figure 5.2 shows the land zoned residential and suitable for future residential purposes in Rockhampton. This totals 510.3 hectares. South Rockhampton possesses 22 hectares or only 4% of the total land zoned residential and available for future residential use. North Rockhampton possesses 488.4 hectares, 96% of the total land for future residential use zoned residential. Thus North Rockhampton in the areas zoned residential, has 22.23 times the area of South Rockhampton available area for future residential expansion.

Areas Unzoned

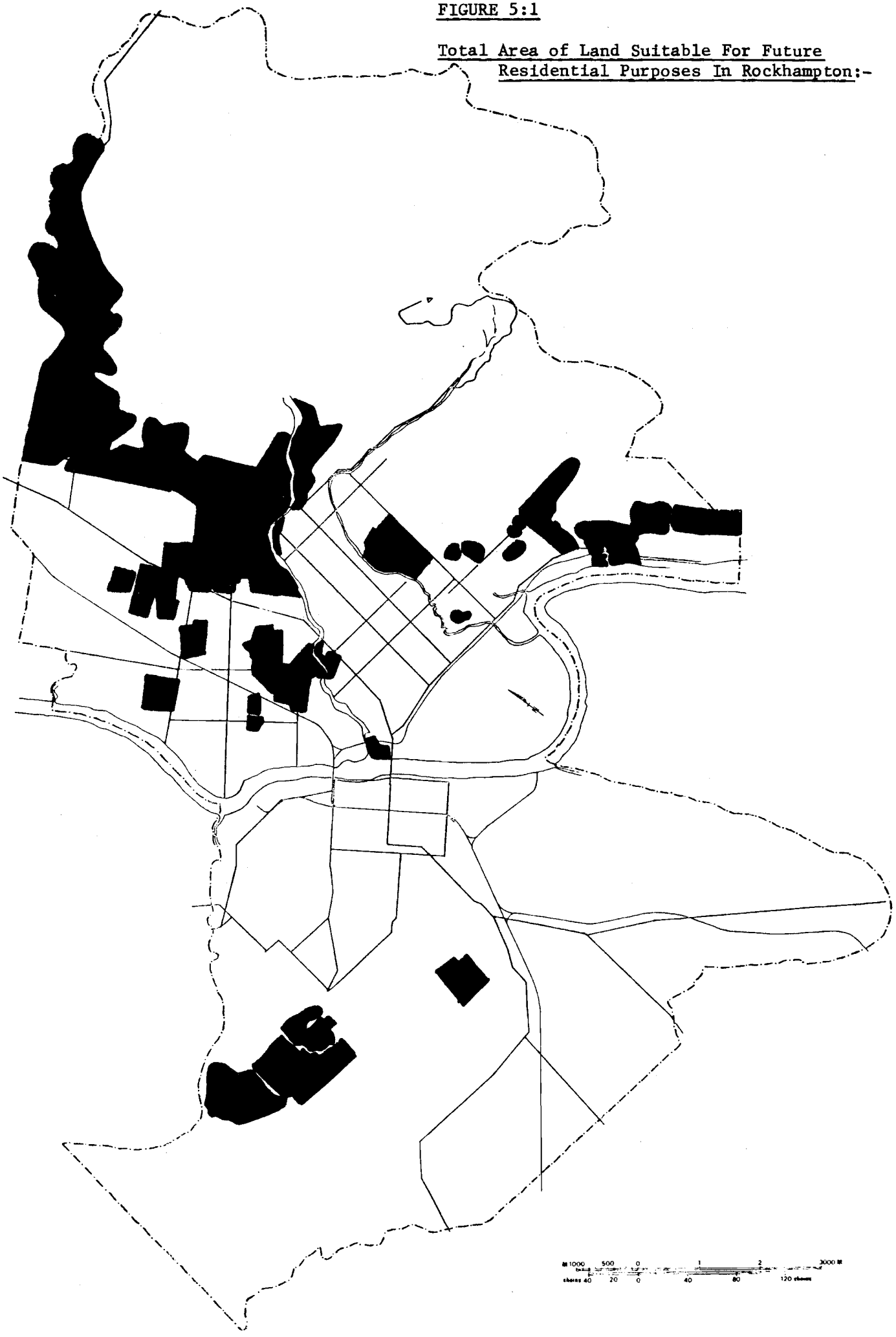
Figure 5.3 shows land suitable for future residential purposes in Rockhampton that is unzoned. The total Rockhampton area is 600 hectares. South Rockhampton possesses 119.1 hectares or 22% of the unzoned land capable of future residential use. North Rockhampton possesses 480.9 hectares or 78% of unzoned land for future residential use in the Rockhampton area, equivalent to 3.5 times the area in South Rockhampton.

Areas Zoned Future Resudential

Figure 5.4 shows land suitable for future residential purposes in Rockhampton zoned future residential. South Rockhampton possesses no such areas but North Rockhampton possesses 128.5 hectares.

FIGURE 5:1

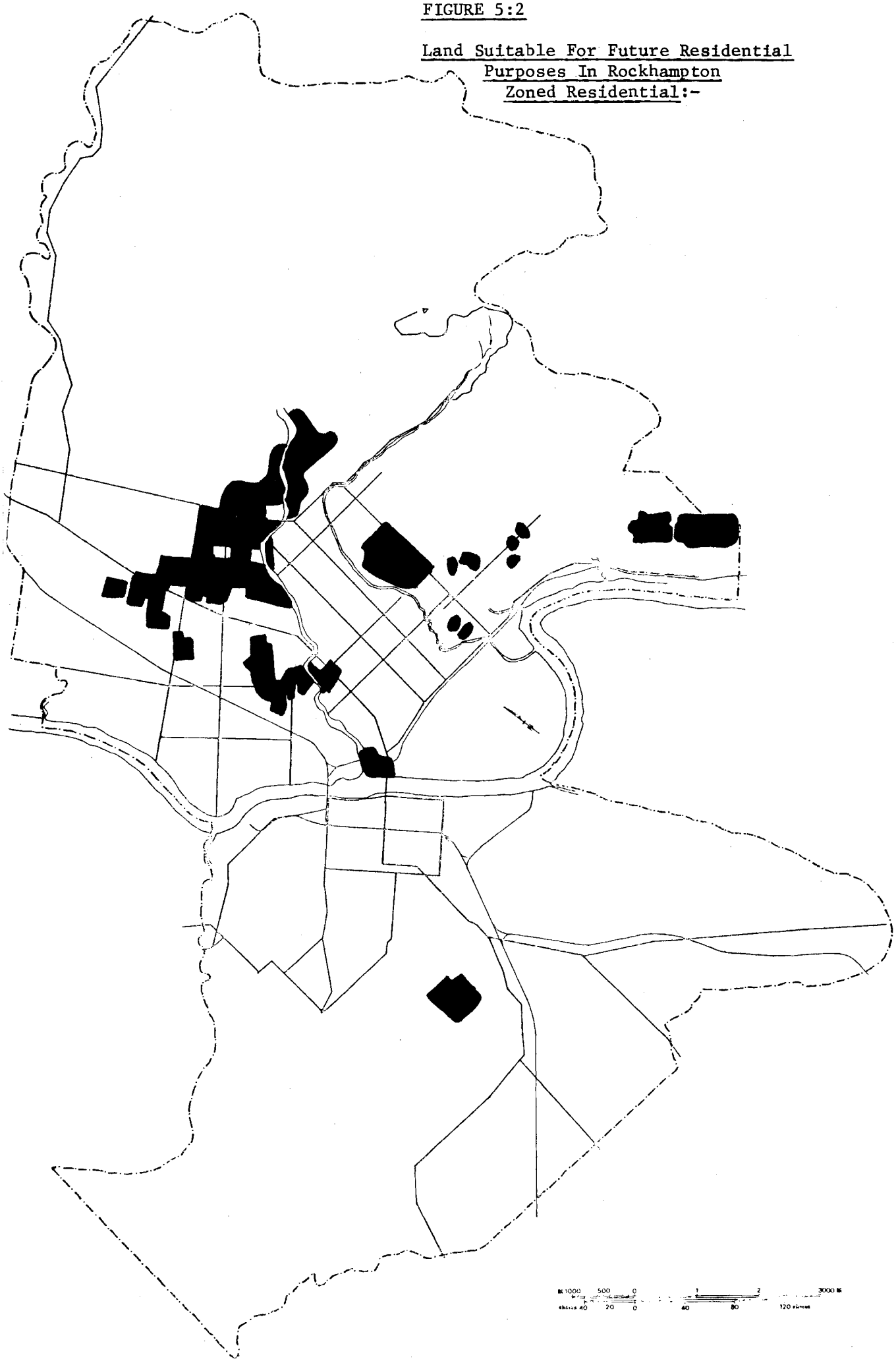
Total Area of Land Suitable For Future Residential Purposes In Rockhampton:-



Source: Cadastral Maps - Rockhampton

FIGURE 5:2

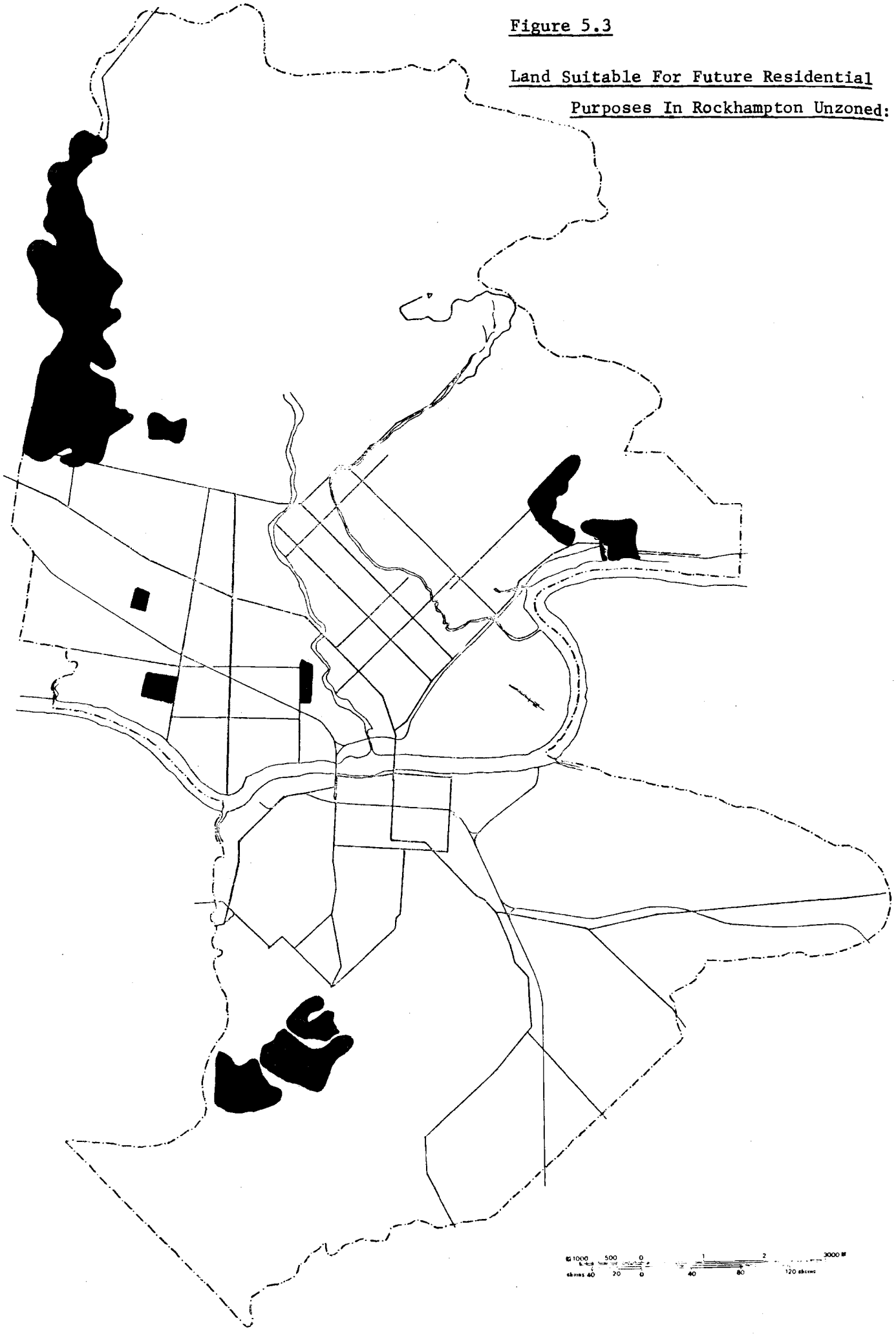
Land Suitable For Future Residential Purposes In Rockhampton Zoned Residential:-



Source: Cadastral Maps - Rockhampton

Figure 5.3

Land Suitable For Future Residential Purposes In Rockhampton Unzoned:

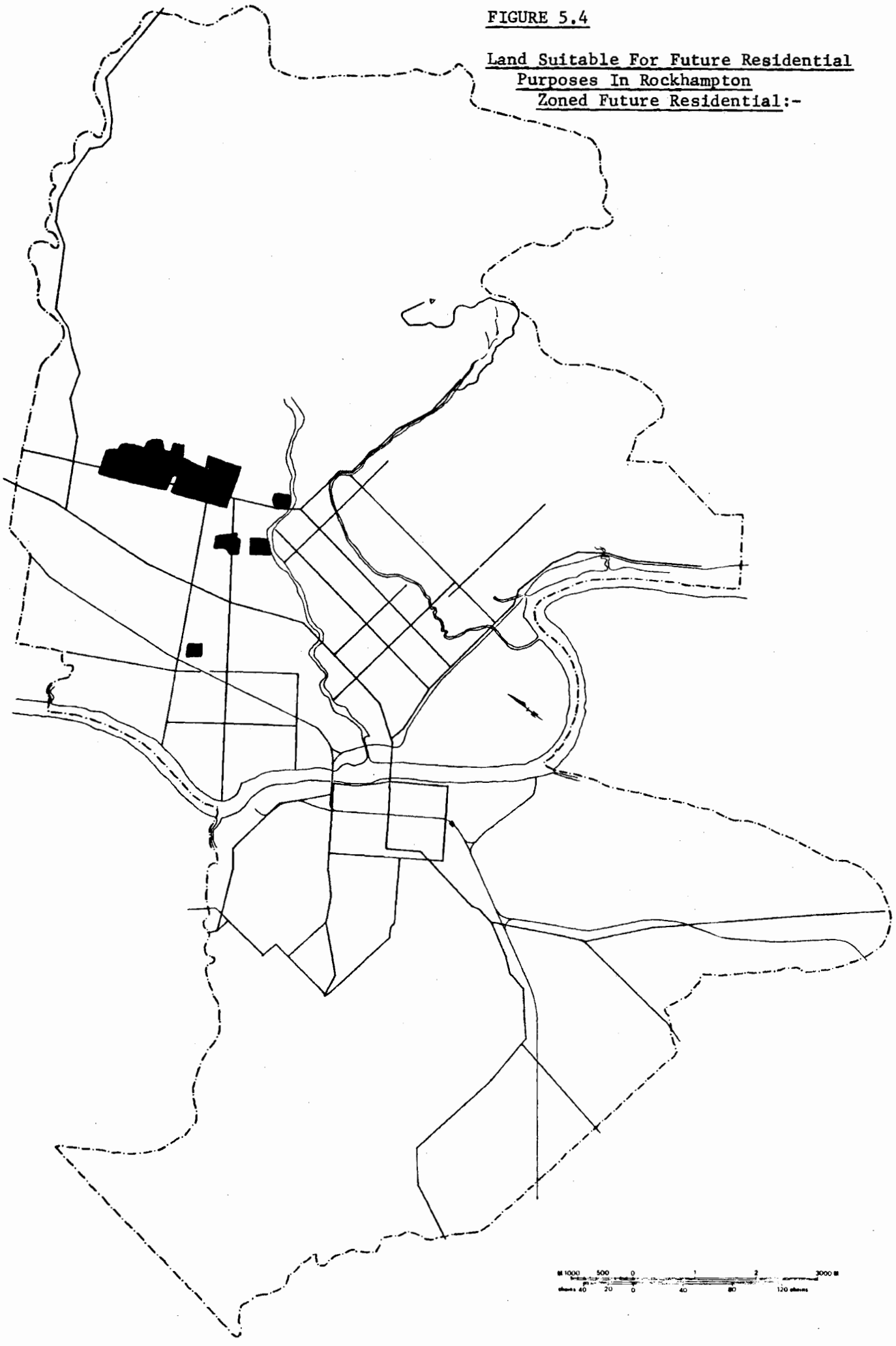


Source: Cadastral Maps - Rockhampton

FIGURE 5.4

Land Suitable For Future Residential Purposes In Rockhampton

Zoned Future Residential:-



Source: Cadastral Maps - Rockhampton

Clearly, North Rockhampton will be the area that will experience the major force of future residential growth.

5.3 Proportion between Areas Already Subdivided and Vacant and Areas Unsubdivided and Suitable for Future Residential Purposes, For the Total Rockhampton and Individual Parish Areas.

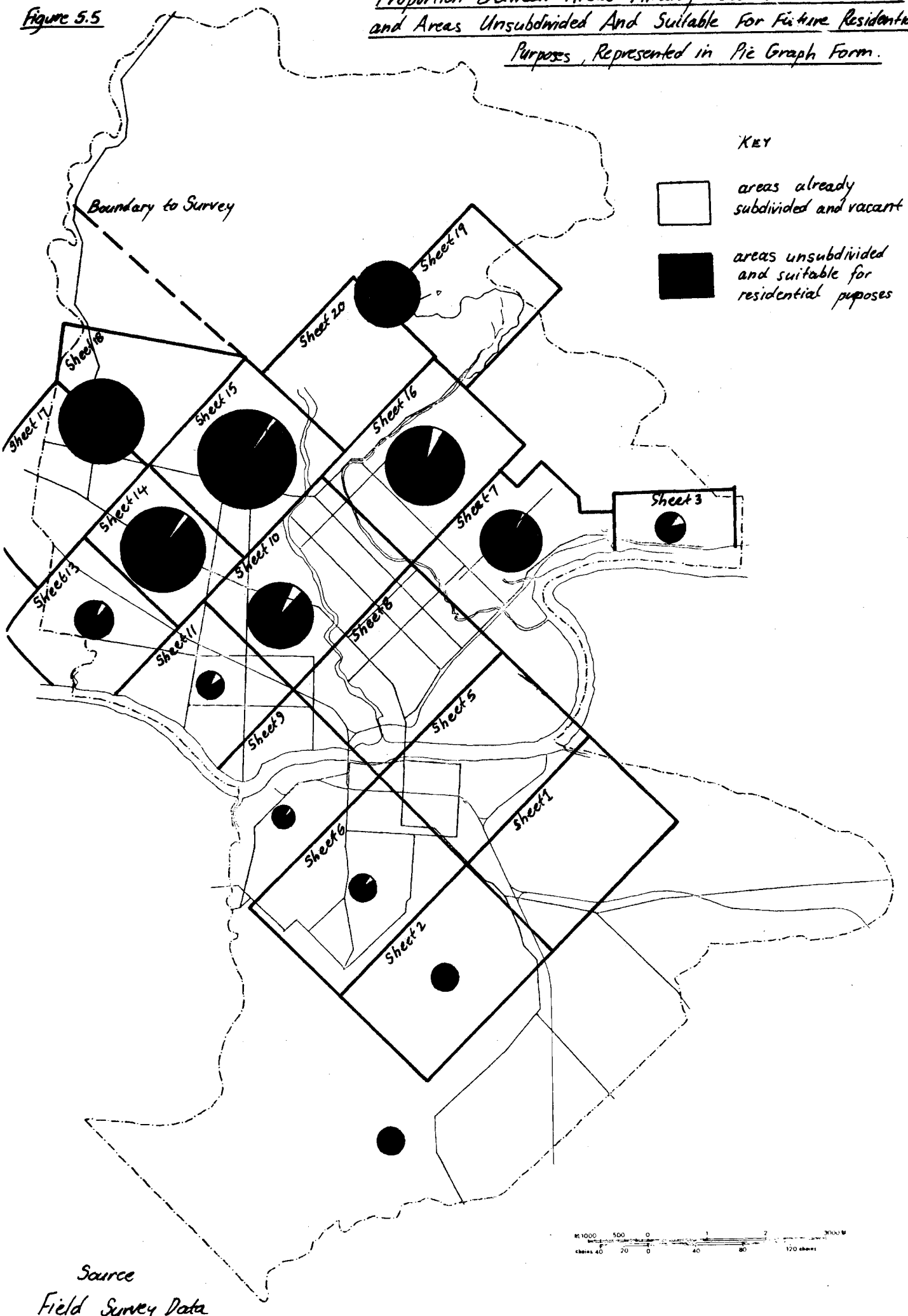
Table 5.1

8 chains to the inch Parish Sheets	Vacant and Suitable land (hectares)	Subdivided and vacant area (hectares %)	Subdivided and vacant area (allotments)	Unsubdivided and suitable area (hectares %)	Unsubdivided and suitable area (allotments)
17,18 and North East	124	Nil	Nil	124 100%	1364
16	136.7	13.8 10%	174	123 90%)	1354
15	232.7	3.2 5%	40	229.5 95%	2524
14	168.5	17.2 9%	218	151.4 91%	1842
13	26.7	2.5 9%	31	24.3 91%	264
11	8.2	1.1 13.5%	14	7 86.5%	53
10	60.7	13.9 23%	176	46.7 77%	514
9	6.8	.7 10%	6	6.1 90%	75
1,5 and 8	Nil.	Nil.	Nil.	Nil.	Nil.
7	87.1	4.7 5.4%	59	82.4 94.5%	928
6	11.1	.5 4%	6	10.5 96%	118
3	18.3	5.3 29%	67	13 71%	163
2	8.7	.2 3%	3	8.5 97%	85
Areas South and South East of 2,6,and 1	105.4	Nil.	Nil.	105.4 100%	1159
Areas Outside of 3,7,16,19 and 20	10.4	Nil.	Nil.	10.4 100%	115
Total	1005.3	63.1	794	942.3	10558

Table 1 and Figure 5.5 show the proportional representation of subdivided and vacant areas and unsubdivided and suitable areas for the parish sheets of Rockhampton. Table 1 also shows that the largest hecterage and number of future residential allotments in Rockhampton was in the unsubdivided and suitable areas in which the majority of future residential growth will occur.

Figure 5.5

Proportion Between Areas Already Subdivided And Vacant and Areas Unsubdivided And Suitable For Future Residential Purposes, Represented in Pie Graph Form.



Source

Field Survey Data

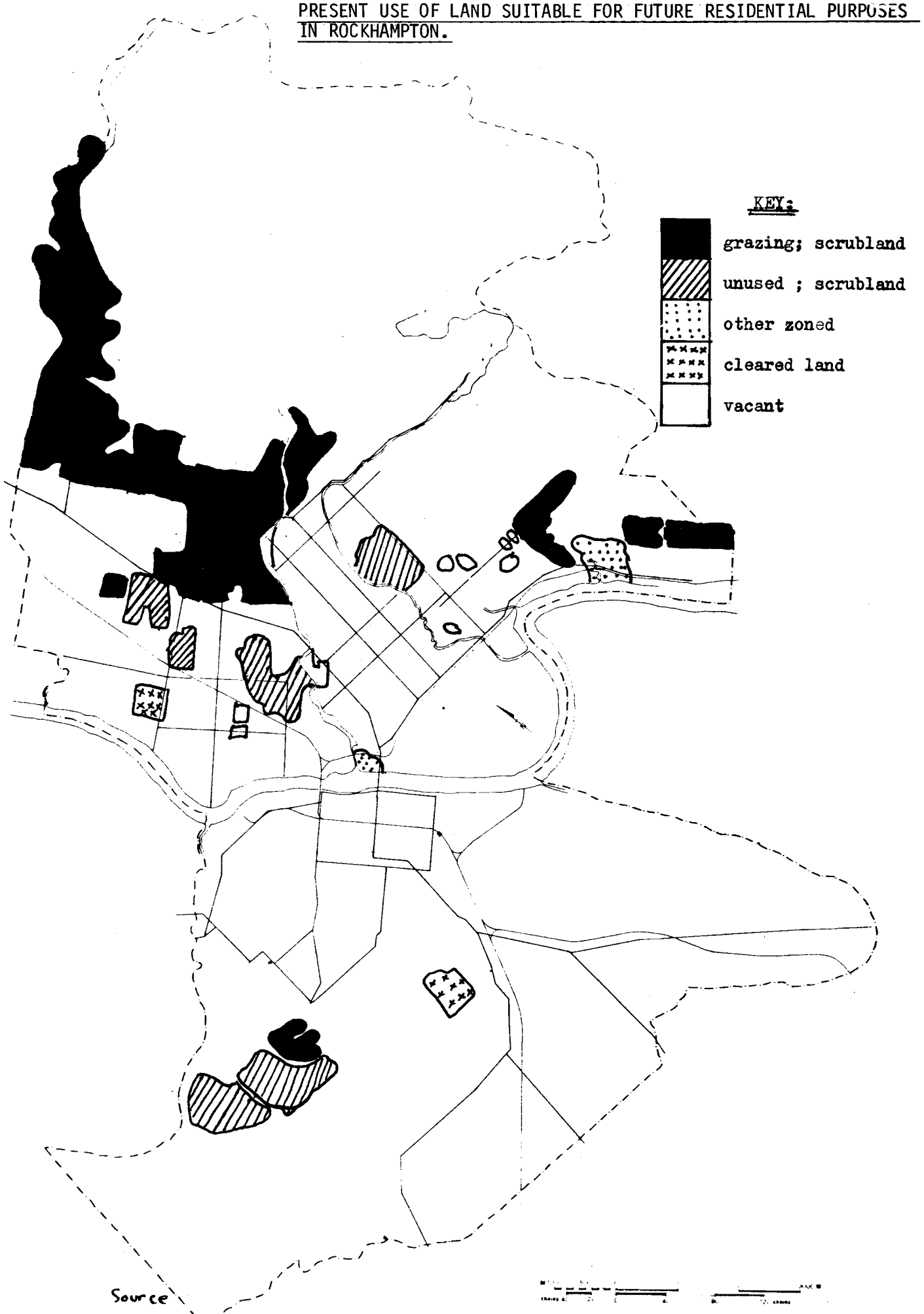
5.4 Present Use of Land Suitable for Future Residential Purposes

Figure 5.6 shows the present use that occurs on the area available for future residential purposes. The present major use is grazing which accounts for approximately 70% of the area unused; scrubland 20%, other zoned land 4%, cleared land 4%, and vacant land 2%.

Hence it can be concluded that the area that will be influenced most by future residential growth will be North Rockhampton. Of this the majority of the area is at present unsubdivided and suitable for residential purposes. The potential of this area is 10,558 allotments which is approximately 12 times the number of plots at present subdivided and vacant. The total area suitable for future residential growth in Rockhampton is 1005.3 hectares, or 11,352 allotments.

Figure 5.6

PRESENT USE OF LAND SUITABLE FOR FUTURE RESIDENTIAL PURPOSES IN ROCKHAMPTON.



Source

Cadastral Maps:- Rockhampton:

CHAPTER 6

Loss of Land in the Conversion Process

Introduction This chapter will deal with the conversion of low land into residential allotments. Four separate subsections are discussed. These are: the area lost for recreational purposes, the area lost to roads and services; the size of residential allotments and the number of allotments by zoning that will become available in Rockhampton in the future.

6.1 Area Lost for Recreational Purposes

Firstly, a definition of what recreational purposes entail will be helpful. What the Rockhampton City Council usually refers to when it talks of recreational purposes is parkland.

When the amount of land the developer has purchased is over eight hectares in size then the amount of land reserved for parkland is 10 per cent. When the area involved is between 4,000 square metres and 8 hectares the Rockhampton City Council is at liberty to ask the developer of that land for $100.00 for each allotment. These figures are reviewed each year in the budget so they are only relevant for the present.

The next question to be asked is where a developer can take his 10 per cent from? That is, can the 10 per cent be taken from land that the developer does not want? These questions are usually debated between the developer and the City Council.

The potential developer and the City Council are both vying for adequate suitable land. The potential developer naturally wants to develop as much land as possible so that he can make as much profit as possible. While the City Council is trying to look after the public's interests so it will not be satisfied to take only 'rubbish' land that the developer does not want to sell. After a compromise has been reached the park land is deleted from the area available for subdivision.

6.2 Area Lost to Roads and Services

In this report the area lost to roads and services was a difficult figure to arrive at because of the variations of a set figure in certain circumstances; for example gullies or difficult terrains which a developer has to deal with. The developer who purchases land which is lined with gullies or steep inclines must be willing to lose extra land to roads and services if he is to develop it to an acceptable standard. The amount of land lost to roads and services can vary from 10% to 35%. Usually though it is between 10% and 15%.

For this report, the figure of 11.7% was taken as an appropriate figure which is between the Council's average figure of 10 and 15 per cent arrived at through their years of experience.

The figure of 11.7% for the area lost to roads and services was gained through a step by step analysis. Firstly the average size of an allotment was calculated to be 711.5 square metres. This was found by taking the average of blocks on newly subdivided landscapes.

It was also calculated that 11 allotments per hectare could be taken out of raw land. This was also calculated from previous land developments and affirmed by Blain Bremner and Williams.

If 11.7% is taken out for roads and services it leaves an average of 106.7 square metres per allotment lost to roads. This would leave the previously stated 11 allotments per hectare. Thus this figure was confirmed in two ways. Alternatively it can be stated that 12.65 allotments per hectare can be created on land where roads and services have already been provided.

When the land taken out for parklands, from the previous discussion, is added onto this 11.7%, a gross figure is arrived at for this report. This is, that 21.7% (10% for parkland and 11.7% for roads and services) of the raw land is taken from the developer before he can establish the amount of useable, suitable residential land.

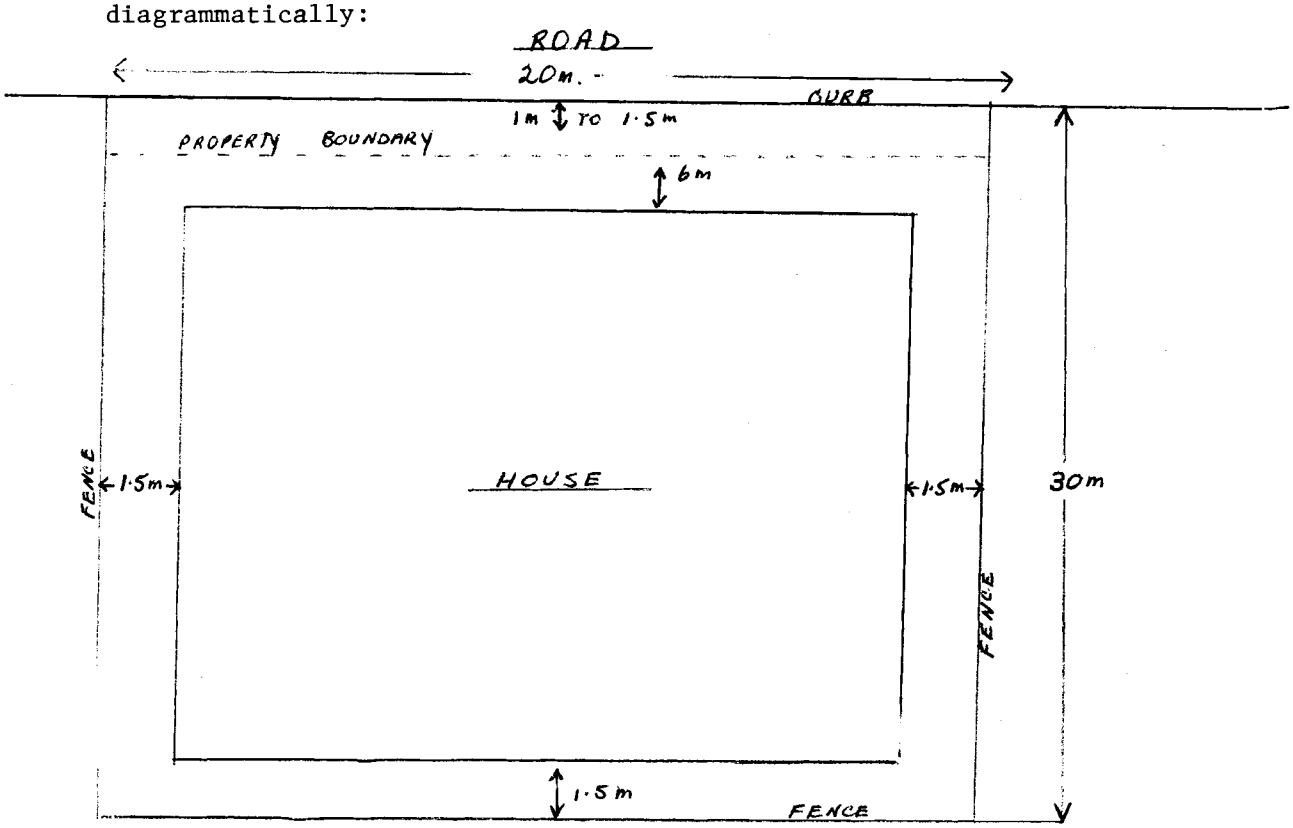
Therefore with 21.7% of land taken out or lost to parklands and roads and services only 11 allotments per hectare of average allotment size can be provided for purely residential purposes.

Size of Residential Allotments

The size of the residential allotment can vary to suit the taste or income of the consumer. There are only a few minimum requirements that the Rockhampton City Council stipulates.

The first is that the size of an allotment may be no less than 600 square metres. This is further detailed that a minimum of 20 metres must be at the front of the allotment, therefore, the minimum requirement of depth back from the curb is 30 metres. The only other minimum requirement is that from the side of the house to the dividing fence of the next door neighbour there be at least a distance of 1.5 metres. Apart from this a house should also be set back at least 7 to 7.5 metres from the curb.

This is quite complicated so it would be better shown diagrammatically:



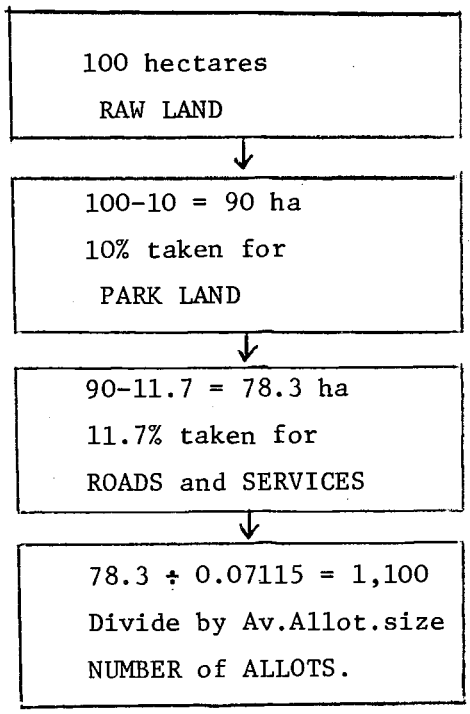
The shape of allotments can be grossly different to this standard block as long as the minimum requirements are adhered to. Examples could be 40 metres in front facing the road and 15 metres in depth or whatever suits the consumer and his budget. This is why the developer usually keeps a variety of allotment sizes at his disposal to suit the consumer market.

The only case where the City Council will make exemptions is when there is a potential consumer who is in dire straits of hardship and can not afford to purchase a block of land with these requirements stipulated. These cases are very rare and the City Council are usually quite inflexible when the areas of minimum requirements are concerned.

The average size of allotments calculated for subdivisions completed after 1960 was 711.5 square metres and therefore well above the statutory minimum of 600 square metres.

6.3 The Number of Allotments Available

All of this can be summarized in a flow chart beginning with the assumption that a developer has 100 hectares of raw land:


100 hectares
RAW LAND
100-10 = 90 ha
10% taken for
PARK LAND
90-11.7 = 78.3 ha
11.7% taken for
ROADS and SERVICES
78.3 ÷ 0.07115 = 1,100
Divide by Av.Allot.size
NUMBER of ALLOTS.

Chapter 7

Calculation of 'Normal' Vacancy Rates

7.1 Rationale

Once land has been sold to a developer and the necessary improvements carried out, it can be assumed that this land will be sold, probably within a relatively short time of going on the market. However, once this land has been sold there is no guarantee that the purchaser will build on it immediately, if at all. Some land will remain vacant because buyers are speculating or investing in land, with no intentions of building on it. Land may also be bought by one member of a family and held in trust for another. It is for the above reasons that vacant land must be taken into account when determining future residential expansions and future population in these areas.

This report aims to predict the amount of land that will remain vacant, for the above reasons, in future residential areas. The objective is to calculate, using presently available data, a measure which will describe the average number of residential allotments left vacant in any area at any time.

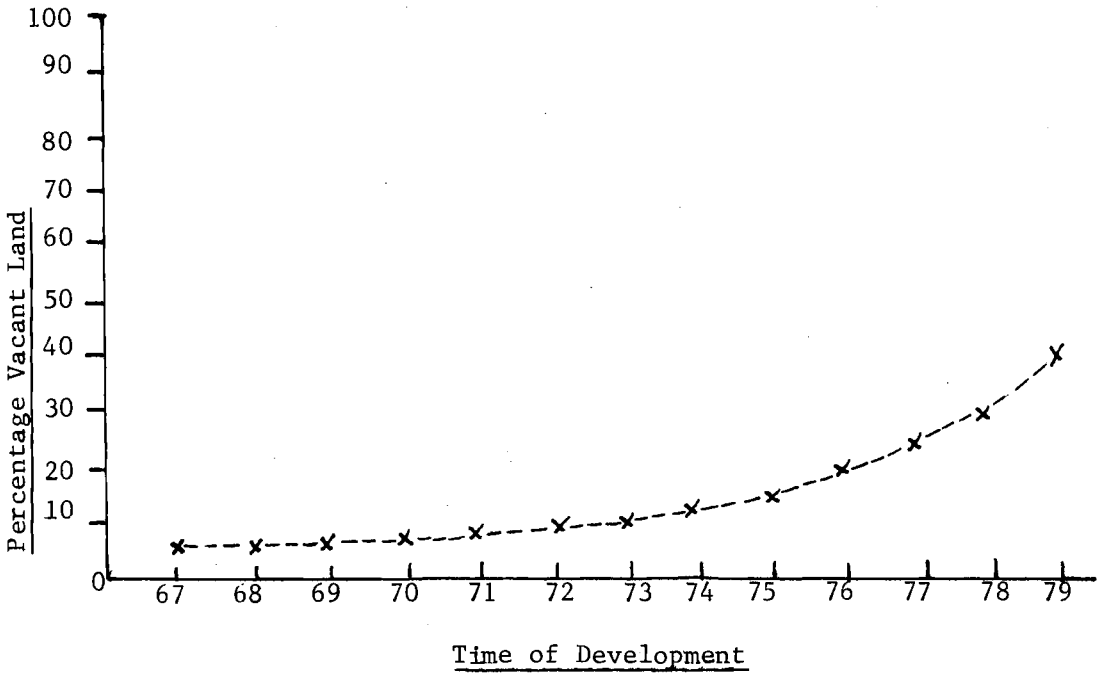
7.2 Methodology

Since the necessary data was not available in the required form, it was necessary to collect the required data in the field. It was decided that the most suitable way of estimating future vacant land would be to look at present vacant land in the Rockhampton area. The problem was to decide how to correlate the present data on vacant land, with predicting future vacant land. Obviously, the more recently developed areas of Rockhampton (such as Oasis Gardens and Frenchville) will have a higher percentage of vacant land than the older, long established areas (such as West Rockhampton, Depot Hill, South Rockhampton and Park Avenue).

The problem can be overcome if the percentage of land left vacant in an area is correlated against the age of that area, age being determined by the time of development, obtained from the subdivision plans of the area. It could be expected that more recently developed areas would have a higher percentage of land vacant than the older areas, thus it could also be expected that if the percentage of vacant land is plotted against the age of the area then a graph could be drawn to show a decrease in the amount of land left vacant as an area ages.

Figure 7.1

Correlation of % Vacant Land by Time of Development



Source: Field Work

Such a graph would now enable one to equate the present vacant allotment data with predicting vacant allotment numbers in future residential areas.

The Collection of Data

In order to derive such a graph certain information is necessary:

(a) Vacant allotment numbers for all areas of Rockhampton,

(b) The date of development for each of these areas.

Time and resource constraints did not allow one to look at vacant allotments in all areas of Rockhampton. Thus a sample of areas was taken. It was necessary that suburbs of all ages be included in the sample.

A 'stratified' sample was taken, thus ensuring a fair representation of all ages of development.

The sample of areas to be looked at was:-

1. Oasis Gardens
2. Frenchville
3. Park Avenue
4. The Range
5. West Rockhampton
6. Kalka
7. Rockonia

Once again time and resource constraints did not allow one to look at the total area of these suburbs, so that a second sample had to be taken to determine areas within each of these suburbs which could be studied in order to calculate the number of vacant allotments for that suburb. This was done using Rockhampton City Council registered plan numbers for each area. These registered plans gave an area of allotments to be looked at, and provided the date that this area was first developed. Thus a sample of registration plans was taken for each of the seven areas.

The subdivision plan numbers were obtained from the Lands and Titles Office, Mapping division. A sample of plan numbers was taken from Rockhampton Parish Maps, held by the above authority, which showed the plan number and the area taken in by that plan. The date was obtained from record books containing all registered plans and their development date.

Recording the Data

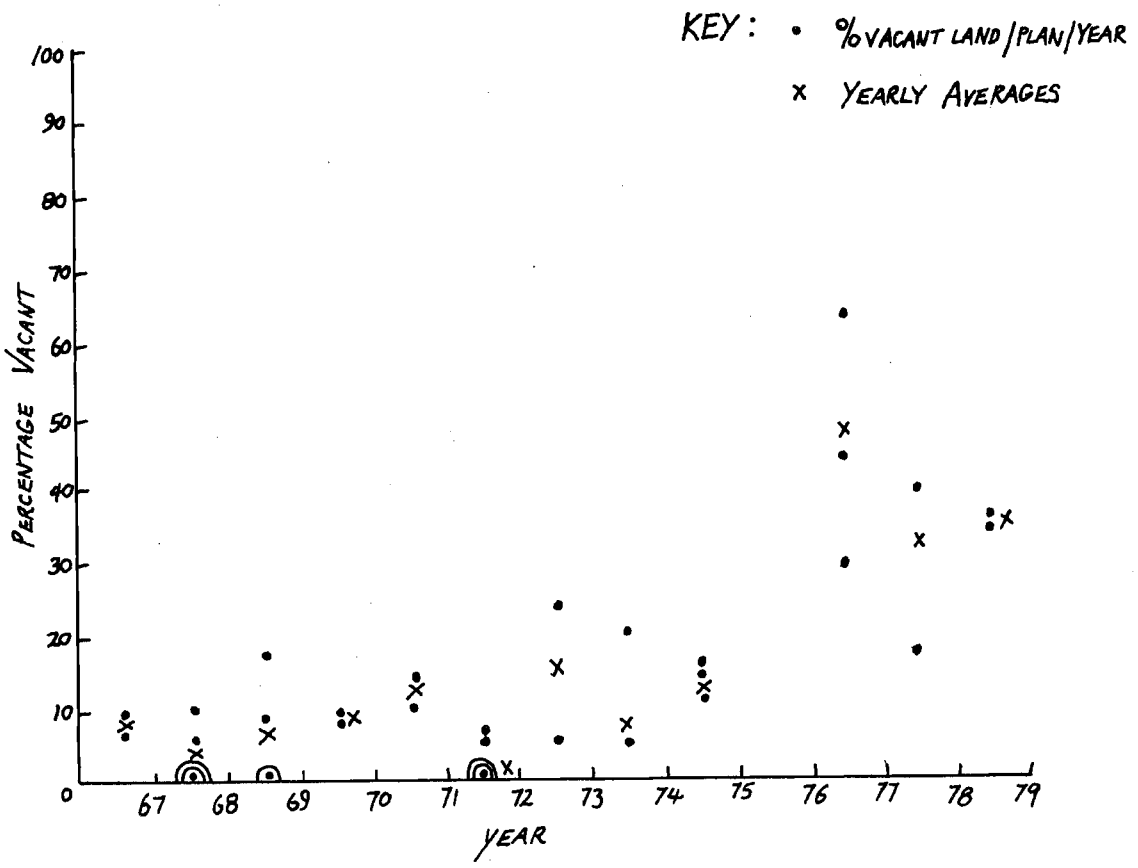
Now it was simply a case of driving around the areas covered by the registration plans and recording the number of vacant allotments for comparison against the total number of allotments and the development date.

These figures on the total number of allotments and the number of allotments vacant then converted to a percentage and plotted against the development date.

Results

Figure 7.2

Percentage Vacant Land Per Year



Source: Field Work

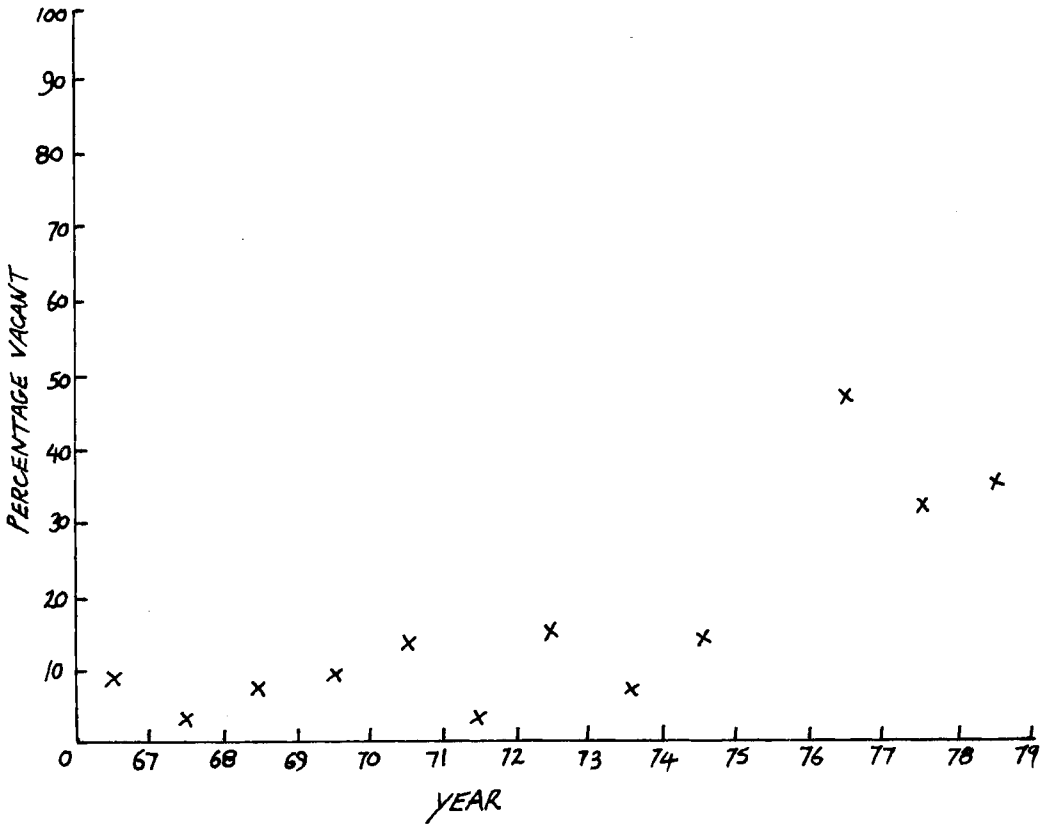
When the necessary data had been collected, the results bore a close relationship to what had been expected. Although there seems to be no specific pattern in the distribution of the black dots on the graph (which represent the percentage of vacant land per plan per year) there is a general pattern which indicates a fall in the percentage of land vacant as one moves back in time. More precisely there seems to be a fall in the range of the two extremities for each year as one moves back through development. For example 1978 shows a range of about 17 per cent land vacant at the lowest and 39 per cent at the highest; 1973 shows a range of 5 per cent and 25 per cent; 1971 indicates a range of 10 per cent and 15 per cent while 1967 indicates the lowest percentage vacant at 8 per cent and the highest at 10 per cent. There are fairly substantial fluctuations

in these yearly figures and some years do not conform to this general pattern. For example 1977 indicates a much higher percentage of land vacant than does 1978 and 1979. This could be due to the relatively small sample taken thus leading to distorted results.

If one takes the yearly average of land left vacant and plots the results, the pattern becomes

Figure 7.3

Average Yearly Percentage of Vacant Land



Source: Field Work

The decrease in the percentage of land vacant as one moves from right to left on the graph indicates that the longer an area has been developing the smaller the percentage of land left vacant.

From this graph two conclusions can be drawn. The years from 1977 to 1979 indicate a constant percentage of land left vacant. An average of these years gives a vacant land percentage of 37.3. This figure indicates that within the first three years of development, an area will have 37.3 per cent of the land remaining vacant. This is not to say the land has not been sold, it just has not been built on.

The second group of figures bearing relationship to each other, are

those percentages of land vacant from 1975 to 1967. If we take an average of these years we find that, once an area has been developing for four or more years, on average 8.4 per cent of that land will remain vacant.

Conclusion

The objective of this report was to determine some measure of estimating the percentage of land left vacant in any new residential development area of Rockhampton. With this in mind two results have been reached which will serve as a basis for estimating the percentage of land left vacant in future residential developments.

(a) After 3 years of development, on average, 37.3 per cent of the land in that area will remain vacant.

(b) After 4 or more years of development on average, 8.4 per cent of the land in that area will remain vacant.

7.3 Anticipated Number of Occupied Allotments by Zoning

This section of the report looks at the number of 'occupied' allotments by zonings. The zonings are:-

(a) Present Residential

(b) Future Residential

(c) Unzoned

The aim is to determine the total number of allotments that will be suitable for residential development (without undue expense) in each of these zonings. By subtracting the percentage of allotments that will remain vacant in each zone, the number of "occupied" allotments can be calculated.

It has already been calculated that there are 10,370 vacant allotments suitable for residential development.

Present Residential

In the area zoned present residential there is a total of 510.7 hectares of land suitable for residential development. If this is multiplied by 11, one can calculate the number of allotments this zone contains (with land for roads, etc. taken out). This will give us 5,618 allotments suitable for residential development. It must be remembered that some development has already taken place in this zone. So it is necessary to calculate the number of allotments already built on.

If one knows the total number of vacant allotments for all zonings is 10,370, and if one adds up the number of allotments suitable for residential development in each zone it comes to 13,518 then it means that 3,148 allotments have already been built on in the present residential zone. This means there are 2,470 allotments still suitable for building on.

If it is taken that 8.4 per cent of these will remain vacant then it can be calculated that in the area zoned residential 207 will remain vacant and thus 2,263 allotments will be occupied.

Future Residential

In the area zoned future residential there is a total of 118.2 hectares of land suitable for residential development. This gives a total of 1,300 allotments. If 8.4 per cent remain vacant this means there will be 109 vacant allotments and 1,191 occupied allotments.

Unzoned

In the area designated as unzoned there is a total of 500.0 hectares of land suitable for residential development. This gives a total of 6,600 allotments. With a vacancy rate of 8.4 per cent, 554 allotments will remain vacant with 6,046 allotments occupied.

Figure 7.4

Summary of maximum future allotments by zoning

Zoning	Amount of Land (Hectares)	Number of Allotments	Expected Number Vacant	Expected Number Occupied
Present Residential	510.7	2470	207	2263
Future Residential	118.2	1300	109	1191
Unzoned	600	6600	554	6046

Chapter 8

The Time before Rezoning is Needed and the Maximum Future Population that can be Accommodated in the L.G.A.

Several assumptions have been made in drawing up the graph in this section.

It has been assumed that the density of the residential population will remain at its present rate. That is, 3.21 persons per dwelling (Table 8.1). This assumption is probably as good as any other, although, the rate has been declining rapidly over the last twenty years, it is unlikely to continue to fall.

Table 8.1

Average Number of Persons per House:

Year	Number
1933	4.76
1947	4.18
1954	3.73
1961	3.62
1966	3.55
1971	3.41
1976	3.21

Source: Australian Bureau of Statistics

A second assumption was the size of the allotment on which each house was placed. It was assumed that 11 allotments could be placed on each hectare of unserviced land and 12.65 on each hectare which already has roads and services provided.

A third assumption concerns the number of vacant allotments in each new suburb. A set proportion (8.4%) of the allotments available will, it is predicted, remain vacant. All of these assumptions are justified elsewhere in the paper.

These assumptions are necessary to estimate when rezoning of further land for residential purposes will be necessary and to predict the date when Rockhampton will run out of residential land.

8.1 The likely future population of Rockhampton

The past growth of Rockhampton's population is shown in Table 8.1

Population Figures for Rockhampton:

Year	Number
1933	29,369
1937	30,000
1941	35,540
1945	34,000
1947	34,988
1954	40,670
1961	44,128
1966	46,052
1971	49,164
1976	51,133

Source: Australian Bureau of Statistics

Although figures dating back to 1933 were obtained, only figures from 1954 onwards were used to model Rockhampton's future growth as figures from the pre-war periods obviously give a false impression of real growth trends.

Figures of expected population were calculated up to the year 2050.

Using the formula:

$y = a + b \ln x$

which provided the best fit to the City's post-war population growth (Table 8.2).

Prediction of Population Figures Using the Log Curve Fit Method:

Year	Population	Year	Population
1954	40,650	2010	67,316
1961	44,025	2012	68,254
1966	46,428	2014	69,192
1971	48,825	2016	70,128
1976	51,216	2018	71,064
1978	52,171	2020	71,999
1980	53,124	2022	72,933
1982	54,078	2024	73,866
1984	55,029	2026	74,798
1986	55,980	2028	75,729
1988	56,960	2030	76,659
1990	57,879	2032	77,588
1992	58,827	2034	78,517
1994	59,774	2036	79,444
1996	60,720	2038	80,371
1998	61,665	2040	81,296
2000	62,609	2042	82,221
2002	63,553	2044	83,145
2004	64,494	2046	84,068
2006	65,436	2048	84,990
2008	66,376	2050	85,911

Source: Predicted from A.B.S. figures 1954-1976.

8.2 Alternative Future Growth Rates

However, it is unrealistic to look at only one future outcome. The growth of the city may slow down or pick up pace. The fastest growing city in Australia over the past few years has been Canberra with a growth rate of some 10.6%* It is extremely unlikely that any city could grow at a rate above this. However, Canberra is proof that this rate of growth is possible.

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* Stilwell, F., Australian Urban and Regional Development, Australia and New Zealand Book Company, Sydney, 1974, Page 27.

We can consider this rate of growth as the upward extreme of those rates worthy of consideration.

At the other end of the scale, between 1966 and 1971 Rockhampton grew only 6.1%, slightly more than 1% a year. * Rockhampton has been extremely stable, fluctuating very little and showing only marginal growth. It is very likely that this state will continue for some years to come. This is particularly true when we consider that any regional growth from now on will have to be shared with Gladstone as it gathers momentum as an industrial centre. On the other hand, with Gladstone growing at a rate of just under 5% annually between 1966-71, ** it is possible that Rockhampton will be stimulated to increase its rate of growth to supply the necessary tertiary industries and administrative services to support the secondary industries located in Gladstone. If this became the case, Rockhampton's rate of growth could conceivably increase. Possibly Rockhampton's growth rate could increase to a rate comparable with Gladstone, or more likely Rockhampton would grow at some lower rate but faster than it would have without the influence of Gladstone; perhaps 2.5%.

To further complicate this picture we are forced to consider the impact of Iwasaki's development and its multiplier effect on the local investment scene. In twenty years, a relatively short period, a significant development will have taken place. Land demand and prices will have risen considerably and many more jobs will have been created. This makes very high rates of growth seem much less incredible. For instance, if we consider the growth rate of 2.5% as being accurate, then Iwasaki would only have to stimulate another 2.5% growth a year to increase this rate to 5%. This would not require Iwasaki to cause the whole of this growth alone, the multiplier effect would amplify his investment as it passed through the local economy.

It is impossible to conclude any one growth rate is the most accurate. Therefore, we shall examine a number of constant growth curves in addition to the logarithmic best fit model (Figure 8.1).

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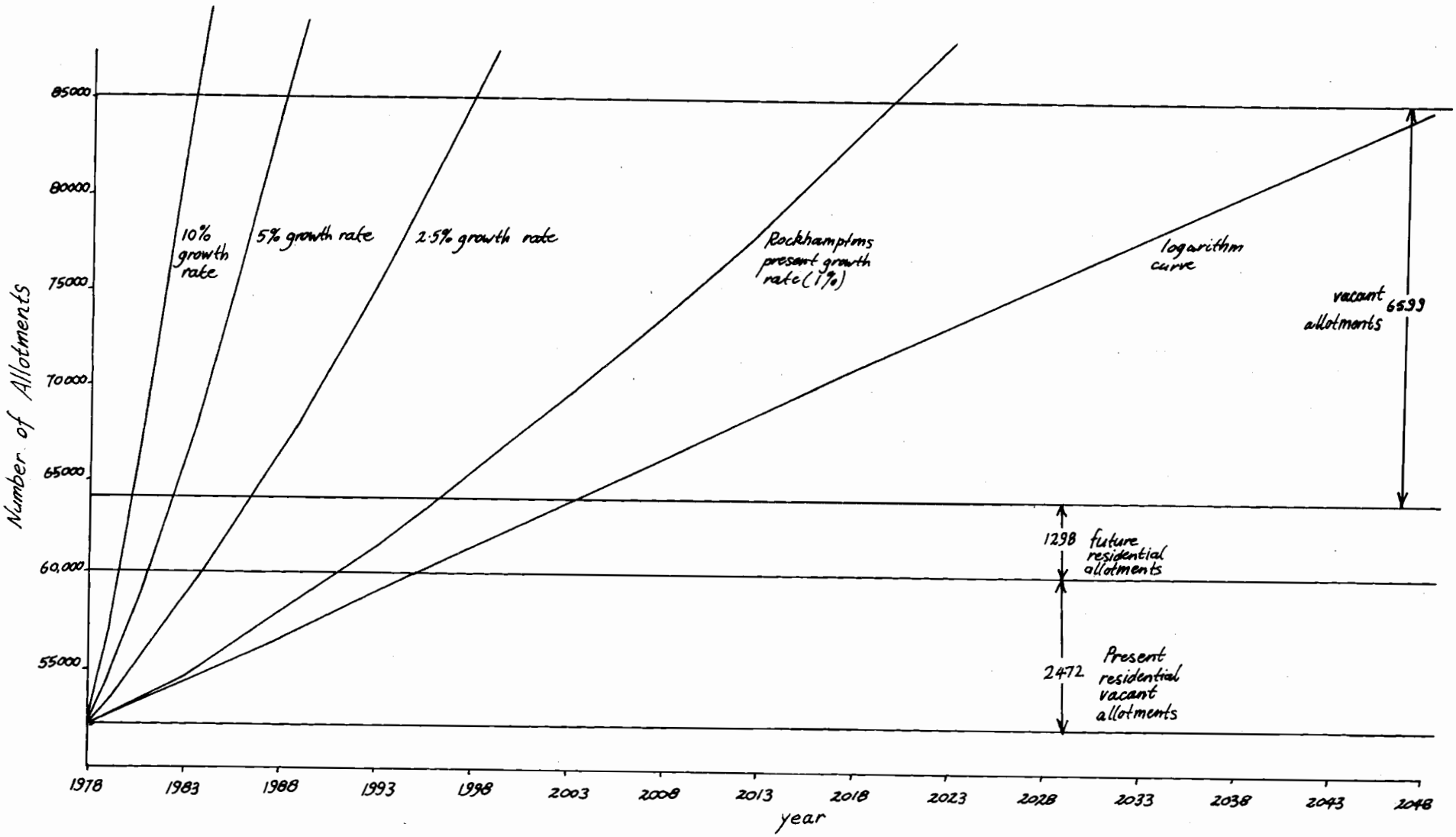
* Stilwell, F., Australian Urban and Regional Development, Australian and New Zealand Book Company, Sydney, 1974, Page 24.

** IBID, Page 24.



Source: Number and type of vacant allotments from field survey

Figure 8
The time to the use of the available allotments given a variety of growth curves

8.3 Conclusions

Some conclusions may be drawn from Figure 8.1. The remaining allotments zoned at present as'residential' will last between 1.5 and 19 years. With such an incredible variation of possible results, this leaves open a whole field of possibilities. At a 10% growth rate the remaining present residential land will be consumed by 1980. At the 5% rate the remaining present residential land will be consumed by 1982; at the 2.5% rate by 1985; at the 1% rate by 1995; at the logarithm rate by 1997. It is probably of significance that, if an average time to the use of this land is taken, it would be 10.1 years. This figure does, however, seem reasonable. It is unlikely, based on past experience, that the land available will be used rapidly.

The average of the five curves gives us until 2001 which would be 31 years supply of residential land.

If, to this total we add the future zoned residential land, the situation becomes a little better. At a growth rate of 10% this additional land will be consumed in just a year. The land zoned 'future residential' will be consumed by 1981.. At the 5% rate the land zoned 'future residential' will be consumed by 1983, once again barely more than 12 months will see the use of this land. At the 2.5% rate 1987 will see the use of this additional land. Only at 1% and logarithm rates will this land supply be a significant buffer to relieve the growth pressure. At these rates the additional land will be exhausted by 2000 and 2003 respectively. It is unfortunate that the most significant gap between the two dates comes when the planning time required is least. The average time to use this additional land is three years.

This isn't the total area available for residential purposes. There is a large area of vacant land also available. At the 10% growth rate this gives us the total land used by 1884. If Rockhampton chose to grow at this rate planners would find their task impossible. The land would have run out before researchers could have established that the growth rate was 10%. By this time there would be 85,450 people in Rockhampton. Consider the impact of this - Rockhampton increasing its population by 60% in five years! The facilities could not handle the growth, yet four to five years would be the minimum time needed to plan for the sort of infrastructure changes needed. The infrastructure in Rockhampton now would have to cope with 33,000

more people. It is fortunate that this is an extremely unlikely growth rate and that it is not foreseeable that we will experience this type of growth.

If the town grew at 5% per year it would be 1989 when the land ran out, eleven years to a land shortage.

Once again the disaster would already have occurred before the city council could react. Ten years is an inadequate period in which to plan and control the growth of the city. All the land would be built on before the development could be adequately planned to ensure the growth of facilities for the use of the 33000 new Rockhamptonites.

The situation changes when we consider the 2.5% growth rate. 1998 is the year by which all the land would be used. This growth rate is not so far from the realms of possibility and so demands more attention. Over a twenty year period about 1,500 people would require about 500 homes to be built annually to house these people (that's nearly 200 houses more per year than were built in the period 1971-1976). This would seem to indicate a degree of prosperity in Rockhampton, still much higher than the city has seen in the last ten years. It is nevertheless an obtainable rate of growth.

Any of the above three possibilities gives the stark picture of the time factor in future growth, any rate at, or above, 2.5% will cause the rapid exhaustion of the land resources of the city. If the city is expected to launch itself off at this rate of growth then the time for planning is now. It is difficult to stem or control growth once it has gained momentum. Now, is the time to plan the city's path and to lay out the city to the people's best advantage.

The last remaining curves show growth as it has been and as it is most likely to remain. The 1% growth rate curve reflects the rate of the early 70's and this would give the city until 2028 before the population would reach 85,450. The logarithm curve gives the city until the year 2048 before the land supply will run out. Both dates show there would be plenty of time for planning and only a slight possibility of big city problems related to higher growth rates occurring. The city's character would not change, in fact, statistically it would continue the same as at present. The allowance of 50 to 70 years before a land shortage is adequate for planning and implies action could be delayed for a few years to come.

All three of these estimates imply that Rockhampton will not experience a land shortage in the near future. However, the time to start planning is now, especially if higher future growth is envisaged.