

AN INQUIRY INTO THE USE OF THE ECOLOGICAL
APPROACH FOR ENVIRONMENTAL AND LAND USE
PLANNING IN THE HOWICK SUB-REGION, NATAL.

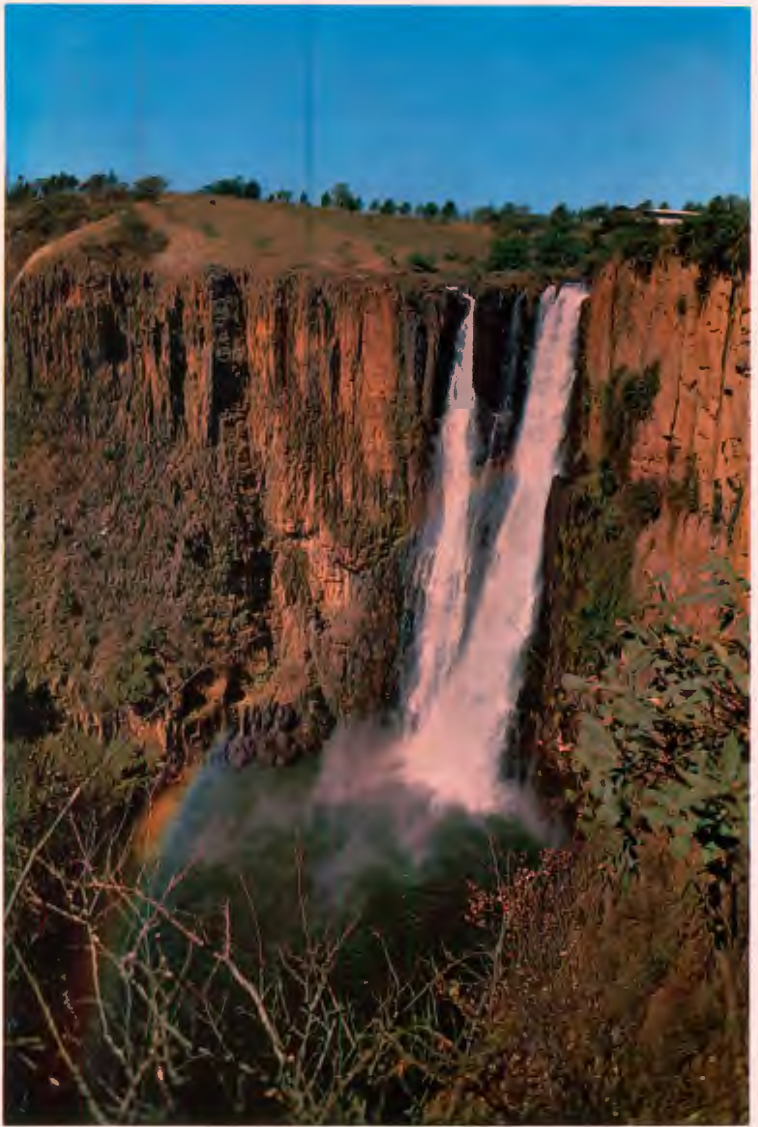
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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Urban and Regional Planning, in the Department of Urban and Regional Planning, at the University of Cape Town.

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The Umgeni River cascades 365 feet down the Howick Falls, the only proclaimed historical monument within the Sub-Region.

(Photo B.K. Bjornsen)

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PURPOSE :

The recent and current world-wide public concern on the erosion, destruction and pollution of the natural environment has led to a reassessment of the discipline of Urban and Regional Planning - or Town and Country Planning as it is termed in Britain.

The purpose of this thesis is to inquire into the hypothesis that the use of the ecological approach as a method for environmental and land use planning is both valid and reliable. The problem has been examined from both the theoretical and the practical application of and testing of the ecological approach.

The inquiry pursues the following objectives:

- (1) to state the various techniques or approaches to land use planning
- (2) to consider, test and apply interpret the ecological approach
- (3) to state and discuss some primary relationships and principles of the ecological approach
- (4) to examine the physical features of the Three Rivers Region and Howick Sub-Region
- (5) to investigate the general need and intrinsic suitability of the Study area for an open space system
- (6) to examine the forces affecting, and critically assess the consequences of industrial location in the Study Area.

LOCATION OF STUDY REGION :

The sub-regional study area falls within the Province of Natal and also within the jurisdiction of the Natal Town and Regional Planning Commission. The Lions River Study Region has also been termed the Howick sub-region. Map 1 shows the regions in which intensive planning and research have been concentrated. The study sub-region thus falls near the boundary of the Tugela basin and the Three Rivers Research Regions.

The Three Rivers Research Region lies between the Tugela and Umkomaas Rivers, and reaches eastwards from the source of the Umgeni River to the Indian Ocean. Some 4,400 square miles in size, the region contains some of the foremost farming land in Natal, and also the Pietermaritzburg - Durban Industrial Complex (Turner 1967).

The Howick sub-region, while falling in the Northern portion of the Three Rivers Region, is some 900 square miles in extent. For administrative purposes the study area is defined as extending from latitude $29^{\circ} 12\frac{1}{2}'$ to $29^{\circ} 37\frac{1}{2}'$, and longitude $29^{\circ} 47\frac{1}{2}'$ to $30^{\circ} 22\frac{1}{2}'$. (Refer to map 1F). Ranging from the Inhluzani Mountain in the west, to Otto's Bluff in the east, the sub-region spreads from Pietermaritzburg city in the south, to the Mooi River in the north. The Lions River Soil Conservation District provides a functional context for the sub-region.

MOTIVATION :

The selection of the ecological approach as the topic of this inquiry rested on both the international current environmental awareness, and the development towards an approach to planning by the writer during the past three years. The indispensable contribution of the social sciences, particularly economics and sociology may be seen in an urban analysis of Wynberg and two papers by the writer (McCarthy 1969, 1970B, 1971 A respectively). The urban analysis adopted the approach of human-ecology (of the Chicago sociological school of thought), to detect areas of homogeneity, dynamic equilibrium, invasion and succession. Parallel to this emphasis on the social sciences, the vital contribution of the natural sciences and the scientific method to land use planning was perceived and applied in practice (McCarthy 1970 A, 1970 C). The latter work provides an illustration of the synthesis of the physical and social sciences in regional problem solving. This present work // aims at considering and applying an ecological or wholistic // approach to the consideration of interrelated variables, and the solution of environmental and land use problems.

The choice of the Howick sub-region was determined by the thesis requirements of original research; special facilities of investigation; specialisation in a field of particular interest; and a contribution to knowledge within its field. To meet these requirements, and with the gracious permission of the Natal Town and Regional Planning Commission, original research conducted in the Howick sub-region has been utilised for this thesis (McCarthy 1970 A).

METHOD :

The scientific method has been adopted. Almack (1930) distinguishes the experimental, normative and historical methods as elements of the scientific method. The inquiry has adopted

the historical method for the determination and presentation of facts, and the normative method to arrive at conclusions and recommendations.

The thesis begins with the theoretical background and framework which provides:- a literature review, and an overview to physical and socio-economic features of the Three Rivers Region in which the Study Area falls; and a brief consideration of the main approaches to land use planning; an introduction to some fundamental concepts in the ecological approach; and, finally, a statement on the method adopted in the problem solving process.

The approach is then applied and tested by means of problem solving. The tests relate to both land use and environmental planning, within the Howick Sub-Region. The problems posed are related to a physical survey, conservation and recreation; and an industrial location analysis. The inquiry is concluded with a critical appraisal of the ecological approach, by assessing the effectiveness of the method to assist decision making, reveal priorities, and indicate alternate land uses within the Howick Sub-Region.

CHAPTER 2 REGIONAL BACKGROUND

2.1 LITERATURE REVIEW

On the Provincial scale, most of the research has been sponsored or published by the University of Natal, and the Natal Town and Regional Planning Commission. The University initiated the compilation and publication of volumes of research in the series, 'Natal Regional Survey', which covers a wide range of topics from archaeology to population distribution. Since its inception in 1951, the Commission has sponsored and published research appertaining to the physical and socio-economic resources of the province. These investigations have been concentrated into the Commission's Research and Planning Regions, vide Map 1. Starting with the Tugela Basin Research Region the emphasis moved to the Three Rivers Region and more recently to the Planning Regions. As the Lions River or Howick sub-region borders on to the Tugela Basin and Three Rivers Research Regions, it is important to take cognisance of the research conducted within the Tugela Basin. This is especially obvious with physical features which do not suddenly change at the arbitrary boundaries of Research Regions. In this connotation, the best literature survey may be found in Phillips (1969, Chapter 4).

Initial research into the geological formations within the Three Rivers Region was undertaken by Turner from 1963-66, for the Commission. Besides compiling new base maps, and profiles of the region, he also isolated the predominant Physiographic Regions, and later presented his research as a thesis to the University of Natal, Turner (1967).

A major contribution to pedological research was ~~was~~ v.d. Eyk, MacVicar and de Villiers (1969) in which the principles and criteria for soil classification, within the Tugela Basin were laid down. A soil map of the Tugela Basin was also provided. This procedure was further developed between 1966-70, when the Commission in conjunction with the University of Natal and the Department of Agriculture assisted Dr. Scotney and R. Ludorf with the preparation of Agricultural land classification maps for the Three Rivers Region. These maps are presently in the process of being published by the Commission. The maps ~~rest~~ on the analysis of soil samples taken from a large number of test holes. Scotney (1970) used the soil

research as the foundation to his thesis. Besides conducting a soil analysis he considered the physical characteristics, and socio-economic forces acting on the Howick Extension Area in order to arrive at conclusions of value to agriculture and land use planning. He concluded his thesis with a discussion on local farm planning. Scotney's thesis is of great importance to this work, as the scope and terrain correspond closely.

Botanical research reached a milestone in the late 1930's with the publication of a memoir by Pentz (1938) on the importance which botanical survey possessed for agriculture. This was followed by Pentz's (1945) agro-ecological survey of Natal, in which he very broadly defined the botanical regions of Natal. Ackocks (1953) refined this classification further. The focus was also sharpened when Edwards (1967) conducted a plant-ecological survey of the Tugela Basin for the Commission. From 1965 to 1969 the Commission sponsored a plant-ecological fellowship for the Three Rivers Region. This research provided the basis for Moll's thesis (1966) which covered the upper Mgeni catchment area - which includes this thesis' study region. His other work, Moll (1967), is still in mimeograph form and awaits publication, and presentation in the form of a thesis.

Together with soil types, the climate exerts a crucial effect on the plant varieties and agricultural capabilities of an area. (a) General body of geographical and climatic knowledge is available to the student. Two micro-studies by Tyson (1963, 1966) regarding wind movements, consider factors affecting atmospheric pollution in South Africa; and local air movements over Cato Ridge, Natal. /A

The agricultural resources have naturally received much attention over the years. Buchanan and Hurwitz (1951) defined the prominent land use pattern in Natal. Burrows (1957) edited the volume in the Natal Regional Survey Series, which is the synthesis of papers delivered at a symposium on the recent developments of agriculture in Natal. Together with Burrows, McCrystal's (1963) preliminary report, also in this series, provides an overall view of agriculture in the Province. Much of this general information relevant to the Three Rivers Region was collected in volume 23 of the Natal Regional Survey Series (1967). The restricted report by Rorsch (1966) for the Commission is a regional assessment of the agricultural potential of the Pietermaritzburg - Durban Region. The Ph.D. thesis

submitted by Scotney (1970) is the most recent and detailed analysis available of the Howick Extension Area, which comprises the Lions River and Mooi River Conservation Districts. Scotney's work is most valuable for the Lions River Study Region. On the other hand, the Commission's 1963-69 fellowship for the co-ordination of the agro-economic research in Natal has culminated in Phillip's (1969) work, which takes agricultural and land use planning into a new realm: not only are numerous research works pertinent to town and regional planning co-ordinated, but the Province is also classified into bio-climatic and geo-bio-climatic regions for the first time.

Water resources have received much attention as this is a prime resource of the Province, and the Commission has undertaken a number of surveys. In 1957, the Commission appointed a committee to investigate the water resources of the Umgeni River System, and the probable future demands on these resources. The committee's results and conclusions were published as volume 7, of the Commission's Reports (vide Kokot and Middleton, 1961). The Natal Regional Survey Series (N.R.S.) in volume 22, on the Pietermaritzburg - Durban Region, Kokot (1963) discusses in a preliminary report the water resources of the region. (Note that Map 1 shows how the Pietermaritzburg - Durban Planning Region overlaps with the Three Rivers Research Region). The Commission also established two fellowships to study the water quality and abatement of pollution in the Three Rivers Region, and in the Tugela River and its tributaries. The surveys were conducted by the National Institute of Water Research (N.I.W.R., 1967). Part II deals with the Umgeni River System. In the same year, the Commission compiled a compendium of information on the more important rivers and dams of Natal. The Commission also appointed a committee, which sat from 1963-1966, to investigate the agricultural development of the source areas of the Umgeni River. Finally a recent paper by Briscoe (1971) develops theoretical models for the economic evaluation of alternate water resource development schemes for the Umgeni River Basin.

In December, 1967, the Umgeni Catchment Association held a hydrological symposium at their sixteenth Annual Conference in Durban. Although Phillips (1969) notes the following papers

which were delivered at the conference, the papers were unavailable for consideration in this work:-

Burney, J.R.	"The Determination of Soil Infiltration",
Du Preez, J.W.,	"Ground water research in Natal",
Nanni, V.W.	"Run off measurements at Cathedral Peak",
Sherry, S.P.,	"The effects of various factors on erosion and run off in wattle plantations in Natal",
Turch, G.	"Capacities by rainfall simulation", and
Wyllie, S.C.,	"Suspended sediment loads in some Natal rivers".

Associated with the developments of water resources is the encouragement and spread of disease. Jackson (1965, 1970) outlines the danger of the spread of the disease from many factors such as irrigation schemes and the disturbance of indigenous vegetation near natural waters. Elschorn - Dew (1960, 1966, 1967) as contained in Phillips (1969), chapter 4 further outlines the nature and dangers accompanying the spread of disease.

A number of general references to water pollution and control, natural resource management and environmental planning have been included in the bibliography at the end of this work.

An exposition of the archaeological resources in the Province is contained in Burrows (1951). The major sites of historical interest are contained in T.V. Bulpin's "To the Shores of Natal", or "Natal and the Zulu Country." As the Study Region fell outside the terrain of great battles and confrontations, it contains very few historically valuable sites. A survey of the recreation industry is contained in Morton (1949) which provides a profile of the holiday industry on the coast, Midlands and Drakensberg areas, in Natal.

A quick overall view of the Province's human and economic resources may be had from the Natal Development Board (1968). The provincial picture of population or human resources is provided, in the Natal Regional Survey Series by Smith (1950), Allsop (1952), Fair (1955); and in the N.T.R.P.C. series, a work by Burrows (1961) who devotes special reference to the demographic analysis of the greater Durban Municipal area. The Commission's Pietermaritzburg - Durban Regional Planning Committee has also undertaken a number of demographic surveys and analyses.

On the southern boundary of the sub-region is the Zwartkop Native Reserve. An overall picture of the Native reserves of Natal is drawn by Brooks and Hurwitz (1957), and Horrel (1969). Further, ²¹in the Zwartkop reserve itself the Department of Economics, Natal University, published an economic survey of the peri-urban settlement of Africans and Indians, entitled, "Experiment at Edendale", in the Natal regional survey series. Van Zyl and Viljoen, planning consultants have recently concluded a survey on the Zwartkop Native Reserve and Edendale Township for the Pietermaritzburg Municipality.

The economic structure and development potential of the Three Rivers Region has also received the attention of the Natal Regional Survey (Horwood, 1967). A series of preliminary reports were issued on: demography (Smith 1964), land and agriculture (McCrystal 1963), land use in the Durban Harbour Area (Hart 1963), water resources (Kokot 1963), Transport and Communications (McCrystal 1963), and finally industrial development (McCrystal and Humphries 1964). These six preliminary reports were in fact combined into volume 14 of the Natal Regional Survey (Horwood 1967). Part I dealt with resources and primary economic activities, while part II covered the secondary and tertiary activities in the Three Rivers Region. In 1970 McCrystal and Humphries also submitted a confidential report on Industrial Development to Pietermaritzburg Municipality. Finally, the Commission's Pietermaritzburg - Durban Planning Committee have undertaken economic surveys and analyses in the Region.

All in all, a considerable body of information has been built up during the past two decades. This, of course, is essential to planning if sound decisions based on scientific data, and not speculation, are to be made.

2.2 THE THREE RIVERS REGION

Map 1 shows the location of the Three Rivers Research Region in relation to the other planning regions in Natal. The three rivers, after which the region is named, are the Umvoti, Umgeni and the Umlaasi Rivers. Turner (1967) delineates the Region as being bounded by the Tugela River catchment in the North, and the Umkomaas River catchment in the South. The source of the Umgeni in the Drakensberg Mountains forms the western boundary and the Indian Ocean the eastern boundary comprising some 4400 miles. The Region is roughly shaped like a parallelogram, but with a bulge into the Drakensberg on the western boundary.

A classification of regions has been formulated by Friedman and Alonso (1964). They distinguish four categories of regions: the metropolitan region surrounding metropolis; a development axis uniting or linking two metropolitan areas; a depressed or economically stagnatory area; and frontier regions where new economic activity occurs. They maintain that the essential aspect of a region is that it is problem orientated.

Abrams (1967) provides a further typology of regions by classifying them into nine types. These types may in turn be classified into four main groups : administrative regions of a jurisdictional unit, e.g. state; homogeneous areas which possess uniform physical features or other characteristics; a metropolitan region as a new city, undeveloped land bordering a city or an international metropolis; and finally functional areas which are unified by common problems, sewage, waterways or flood control.

The Three Rivers Region has been delineated on the basis of physical unity, that is the watersheds to the Umvoti, Umgeni and Umlaasi Rivers. The physical criterion has been influenced by socio-economic criteria so that the Region contains the Durban Metropolitan Region, the developing Pietermaritzburg axis; and the functional and problem areas, such as the regional water supply areas and control of river systems.

2.2.1 PHYSICAL FEATURES

Topographically the Three Rivers Region may be divided into four altitudinal zones with the appearance of 1500 ft steps rising from the sea to the Drakensberg. These steps broadly correspond to Phillips' (1969) Bioclimatic Sub-regions. Increasing in altitude towards the Drakensberg, and moving westwards from the coastline, these four main steps are : the Coast

will
Lowlands (1); Coast Hinterland (2); Mist Belt (3) and Highland to Submontane (4). These four groups, very broadly speaking, run parallel to the coast, and as they increase in height they have a step-like pattern. (See appendix - Bioclimatic Sub-regions)

Crossing these steps at right angles are the valleys of the major rivers which drain in a south-easterly direction to the coast. The riverine valleys are from the remaining two Bioclimatic sub-regions, within the Three Rivers Region. The riverine and interior lowland (number 10) cut deep gorges through the first step, the Coast Lowlands (1) and the second step, the Coast Hinterland (2). In the upland reaches of the Umgeni, Umzimdusi and Umlaasi Rivers the valleys form the Bioclimatic sub-region upland and wooded Savanna (6).

The following geological and climatic information has been taken directly from N.I.W.R. (1967). They note that :

Cut for
over
top
could
be done
in
own
winds
"Geologically, the structure of the Three Rivers Region is fairly simple (as shown in Figure 4, Appendix 5.). Because the strata are almost horizontally disposed, the Beaufort rocks which build the western tip of the Region are followed in normal sequence by outcrops of the successively older and lower-lying Eccca, Dwyka, Table Mountain Sandstone and granite rocks, the outcrops become exposed as the land surface falls away to form belts in the above order. The belts running roughly parallel to the coast are very irregular where the river valleys incise them. Near the coast, however, the Table Mountain Sandstone, Dwyka and Eccca rocks occur again in reverse order owing to the presence of the Natal Monocline, which causes the strata to dip steeply towards the sea. The situation in the coastal region is further complicated by faulting, so that small outliers of some of the formations occur out of the expected order of succession. At the coast itself there are also deposits ranging from Tertiary rocks to those of Recent age, which occur nowhere else in the Province.

The average yearly rainfall over the Three Rivers Region (see Figure 5, Appendix 5.) is about 36 inches, being greatest in the vicinity of Mount Gilboa south-east of Greytown (over 50 inches) and lowest in the valley of the Umlaas south of Camperdown (23 inches). In general the elevated country forming the boundaries of the Region and the coastal plain receive a greater annual rainfall (exceeding 40 inches) than the central portion. Some 70 per cent of the annual rainfall of the Three Rivers Region occurs in summer.

In summer, average temperatures of 24°C or more are experienced at the coast. Mean temperatures decrease progressively as one proceeds inland so that they are about 20°C, or a little below, at the extreme western tip of the Region, the daily range being about 7°C at the coast and 13°C inland. In winter, the average temperatures are about 16°C at the coast and 10°C inland, while the daily ranges are respectively 9°C and 17°C. These effects arise mainly because of the increasing altitude away from the coast.

The annual evaporation ranges from about 60 inches inland to just below 50 inches at the coast, so that at most places in the Three Rivers Region it exceeds the annual precipitation."

The titles of the Bioclimatic Groups are based on biotic potential. Phillips (1969) defined and delineated the Bioclimatic Groups for virtually the whole of Natal. He used the following parameters to define the groups: biotic potential, altitude and climatic factors, such as humidity range, humidity mixing, saturation deficit; rainfall, temperature, frost and snow and evaporation mean. Other important physical features which were considered are geology, soils and land forms. The following description of the Bioclimatic Groups or Sub-Regions has been extracted from this work (Phillips 1969 and 1970 B).

Group 1, the coast lowlands stretches some five to twenty miles inland from the sea. This group has a biotic potential of evergreen forest, short forest, bush and wooded savanna. Its elevation range is below 1500 ft. (457 m) with a climatic range from humid to humid sub-humid. Rainfall is also high, ranging from 33.4 to 55.1 inches (850 - 1400 mm) and upwards. The geological formation is predominantly Karroo sediments and Recent to Tertiary sands. Most of the soils are good to moderately good in terms of a productivity rating. Some of the series are very erodible which has an important bearing on sugar cane production, which is an important crop. The group is favourable for general crop production and forestry. This group has the greatest potential in the Province. To the south of Durban the Bantu areas fill this coast lowland. The population densities and livestock numbers are reaching a point of saturation in the Bantu Reserves, in the coast lowlands and throughout Natal. The population and economic centre for the province is the city of Durban.

Phillips' group (2), the Coast Hinterland, stretches inland to an altitude of 3,000 ft. (914 m). It includes the deeply eroded valleys aligned along the axis of the Natal monocline, with topography similar to the 'valley of a thousand hills'. Further inland group 2 incorporates the Plateau and tilted blocks of the Natal Coast Hinterland; also moving further inland to include Pietermaritzburg on the Pietermaritzburg-Richmond benchland. (This falls on the border of the study Sub-Region or Howick Sub-Region.) The biotic potential is similar to the Coast Lowlands, group 1, and is defined as evergreen and short forest, bush and wooded savanna, with a climate ranging from humid to sub-humid. Together the Coast Lowlands and Hinterland, groups 1 and 2, cover the greater portion of the Three Rivers Region. The geological structure is mixed with the Cape and

Karoo Systems. The biotic potential is suitable for arable and pastoral farming, the production of timber, pulp and wattle. The rugged terrain combined with a high rainfall often induces soil erosion. Sugar, coffee, sub-tropical fruit and cattle could be undertaken on an expanded scale. Pietermaritzburg and most of the Bantu Areas throughout the Region concur with this coast Hinterland group. (Map 10)

The Mist belt, and upland Forest, Group 3, as defined by Phillips, has a biotic potential of Evergreen Forest, Upland Evergreen Forest and wooded Savanna. The higher altitudes, between 3000 to 4500 feet (915 - 1372 m) correspond with a humid to humid sub-humid climate. The rainfall ranges between 31.5 to 62.9 inches (800 - 1600 mm). Map 1A shows this group to be the important timberbelt with sugar grown to the east of Greytown. Local iron deposits occur. The Mist belt lies above the escarpment and stretches in an arc through Richmond, Howick, North of Pietermaritzburg to Greytown. The orographic effects of the escarpment are such that low level morning and evening cloud and mist are common.

The Mist belt is almost a transitional sub-region between groups 2 and 4 (coastal hinterland and montane), where common to these groups the mist belt requires a high standard of agricultural skill to fully manage the soil and water resources. The Mist belt group closely follows the Ecca beds, but with an extension over T.M.S. south-west of Greytown. The soils series have a wide rating range from good to very poor. The soils are noted for problems in regard to low fertility, and or acidity, and collapse of structure with continuous cultivation.

Further, Phillips notes that the Mist belt is highly favourable to the establishment of legume pasturage and permanent grazing for dairy and beef. As with the best portions of Group 4 the Highlands, parts of the Mist belt are amongst the best areas for cattle in the country. Finally, wattle is of the first-class quality. The Mist belt is also favourable for maize, potatoes, luxury crops, flowers and vegetables for the city markets. Other fruits may be grown in selected sites. Phillips rates the Mist belt as the best group for annual crops, cattle production, and is second in importance for agricultural productivity.

The Highland, Podocarpus - mixed Evergreen Forest, Thicket and Woodland, group 4, extends between the altitudes of 4500 - 6000 ft. (1372 - 1981 m). Climate is humid to humid sub-humid,

with rainfall ranging between 31.5 to 59.1 ins (800 - 1500 mm). The rainfall regime is similar to the Mist belt, with a cooler temperature. Frost occurs over long periods and is moderate to severe. On the higher slopes snow occurs locally, but for short periods. The high rainfall collects in the streams and sponges to form the upper catchment areas for the major rivers, notably the Umgeni, which is dammed lower down at Midmar, in the Mist belt, group 3. The rural villages and towns have little prospect of expansion through border industry growth. Unlike Pietermaritzburg, agricultural development should ensure the maintenance of the standard of living. As in the Mist belt fertility is low in the Highlands, but fertilizers can mitigate this factor. The very steep terrain poses problems of preventing sheet and gully erosion. The Highland group forms an important part of the Howick Sub-Region. Phillips also places this in the top group for actual production for annual crops, veld pasturage and cattle. This is a good agricultural area.

The Upland Mixed thicket, group 6, occurs between the same altitudes as the Mist belt. The biotic potential is Upland Mixed Thicket and wooded Savanna with examples of gross ecosystem systems of Themeda-Hyparrhenia and Tristachya-Digitaria moister faciation, with rainfall ranging between 31.5 to 39.4 inches (800 - 1000 mm) and the maximum is thus well below that for any other groups discussed. Frost is an important factor limiting agricultural potential, occurring over several months. The pasture land has been reduced by mismanagement. The soil's E1 associations have a good to moderately good potential, through the range to E5 poor soils, sandy sour veld, is unlikely, Eragrostis pasturage is probable. The soil, climate and infrastructure indicate that production potential should rise in the future, with improved knowledge.

The Sub-arid riverine and lowland, group 10, corresponds to the incised river valleys and lowlands. Group 10 thus occurs at right angles to the bioclimatic 'steps' and groups 1 (Coast lowlands) and 2 (Coast Hinterland). The group falls predominantly between the altitudes 500-1000 ft, but also extends to 2000 ft. (152/457-915 m), as is the case in the Upper Umgeni above Pietermaritzburg. Generally the climate is sub-arid and rainfall is very low, 23.6 to 27.6 inches (600-700 mm), and frost occurs. The biotic potential is Sub-arid Riverine and Lowland mixed Scrub and wooded Savanna. The group always occurs in river valleys and gorges, so water for irrigation is often

is often available, though the gorges are too steep for cultivation.

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This lowland sweet-veld is often over grazed with thorny and other woody elements being encouraged. The development of water for irrigation would have the greatest benefit on this group. Although it is best suited to cattle, its actual annual and perennial crop production is very low.

The Region thus has very varied physical features ranging from the fertile coast lowlands group 1, through the less fertile coast Hinterland group 2, Mist belt group 3 and Highland sub-montane group 4. Productivity falls considerably for the Upland Wooded Savanna group 6, with sub-arid Riverine and lowland the second lowest productive group in the Region and Province.

2.2.2 SOCIO-ECONOMIC FEATURES

The population of the Province and the Three Rivers Region is concentrated in the Urban Centres. The Natal Development Board (N.D.B. 1968), note that Natal is the smallest province with the greatest population density. In 1967 her total population was some 3.4 million souls; under 20 per cent of the total population of the Republic. The Whites, Coloureds and Indians are all urbanised, with over 80 per cent of their numbers in Urban Areas.

The Pietermaritzburg-Durban Planning Committee undertook a population survey and forecast, from which the following figures are taken. (vide Appendix 2.)

The Committee expects the total population within the Three Rivers Region to rise from 1.4 million in 1960 to 2.2 million in 1980 and 3.4 million by 2000 A.D. The population distribution is such that the Whites, Coloureds and Asiatics are concentrated at the Urban Centres of Pietermaritzburg, the capital, and Durban. The Bantu Areas are predominantly distributed in a belt along the coast and coast Hinterland. Map 1D also shows the Zwartkop Native Reserve to the west of Pietermaritzburg and Impendhle Native Reserve, even further to the west. Phillips (1969) notes that the human populations in these Bantu Reserves are reaching a physical level where erosion and other consequences are likely to increase to a serious condition.

The population density of coast and coast ~~Hinterland~~ ^h has been calculated by N.I.W.R. (1967) to exceed 200 persons per square mile, whereas the interior of the Region falls

dramatically to 70 persons per square mile. They note that: in the Bantu areas which cover 30 percent of the Region, the population density may range from below 100 to exceed 500 persons per square mile.

The Pietermaritzburg-Durban Planning Committee observed that there is a marked urban-rural distribution. Of the 1960 total Regional population of 1.4 million, approximately 0.9 and 0.5 million persons resided in the urban and rural areas respectively. This may be expressed in relative terms. In 1960 the two centres of Pietermaritzburg and Durban contained about 27% of Natal's population and 55% of the Three Rivers population. The capital and port are thus major labour pools which markedly influence industrial location.

The Development Board notes that a major problem throughout the Province is to provide employment for the population which is growing at a rate of 2.5 per cent per year. (See also Population Statistics.) They recorded that the qualitative aspects of the labour force are such that nearly all administrative, technical and managerial work is performed by the Whites. Coloured are usually employed in higher semi-skilled positions. The Indian make good skilled workers. The Bantu is a good worker in repetitive machine operation, manual labour and domestic service.

In terms of size, Durban is the dominant city in the Province and Region, while Pietermaritzburg, the capital, is the sub-dominant. Pietermaritzburg, besides being the administrative centre, is a commercial and financial centre to the farmers in the upper portion of the Region. The capital is also noted for its large number of schools, colleges, teaching hospital and a University. Durban primarily differs in possessing a harbour function. The Board stated that the harbour handles some twenty million tons of cargo per year, or dealt with some 6000 ships per annum since the Suez crisis. Durban is also the gateway to the international export market for Natal and the Vaal triangle. The Region absorbs some 60% of all general cargo landed at Durban, and produces two thirds of all exports shipped from the port.

In the past Durban has accounted for about three-quarters of the industrial output of the Province. The industrial development in Durban has been based on four main factors: the availability of labour, abundant water, harbour facilities, and proximity to vast natural resources and agricultural production,

such as coal, sugar and timber. (N.D.B. 1968)

The major satellite towns in the Region are agriculture-orientated (N.I.W.R. 1967). The three largest coastal towns within the Three Rivers Region are Stanger, Tongaat and Verulam. The three lie to the north of Durban. Verulam is the smallest, 2600 persons, and is dependent upon building board mill which uses timber from the Mist belt. Tongaat, 8800 people, has the largest of the eight sugar mills within the Region. (Sugar mills are particularly important for water pollution.) The N.I.W.R. (1967) recorded that the Tongaat Sugar Mill is the largest in the southern hemisphere and possibly the largest in the world. Stanger, population 9500, is an administrative and commercial centre to the surrounding sugar lands.

On the Pietermaritzburg benchland or Mist belt and coast Hinterland Bio-climatic Groups, lie the other three major towns. Richmond, with a population of some 2500, is located to the south of Pietermaritzburg. It is mainly a wattle and dairy centre. Howick and Howick West, population 8000, rest on the upper edge of the Umgeni Gorge. Howick, although primarily a forestry centre, is also a holiday resort. Finally N.I.W.R. stated that Greytown, with a population of 8000 people, and as a wattle centre, is the largest town in the inland portion of the Three Rivers Region. The economic picture is clearly dominated by the huge urban and industrial complexes of Durban and Pietermaritzburg. Apart from the two cities the Region is essentially orientated towards agriculture (Map 1A).

As the Three Rivers Region economically dominates the remainder of the Province, so too its economic development potential is directly related to the whole Province. The Development Board (N.D.B. 1968) show that the Province has experienced a satisfactory development between 1960 to 1964. Future economic growth will rest on : the expansion of the existing economic activity, infrastructure and natural resources, and government policy. Map 1A shows Natal's endowment with agricultural and mineral resources. Mining in Natal relies upon coal in the northern areas and limestone in Port Shepstone. Agriculturally the coast lowland and coast Hinterland have a high potential not only for sugar but also for forestry, sub-tropical fruit, dairying and beef production.

The infrastructure, as shown on Map 1C, is extensive throughout the Region. The Main Road - rail communication axis linking the Reef and the Coast bisects the Three Rivers Region. Not only

does a dual highway from Durban and Mooi River, but a double electrified railway line extend from Durban to Johannesburg. Electrical power is abundant, with every sizable town in Natal receiving its power from E.S.C.O.M. There is an extensive infrastructure network between and at all the main towns and cities within the Region.

Water is one of Natal's richest resources, and a rare resource in dry South Africa. The Board (N.D.B. 1968) state that Natal possesses eight major catchments, each covering approximately one thousand square miles, and discharging into the Indian Ocean. Of these eight, the Umgeni is particularly important because of its proximity to the water use and urban centres. There is adequate water in the Umgeni and Umlaasi Rivers to support a population of twenty million persons. Map 1B shows the disposition of the major dams and rivers throughout the Region and the Province.

The Board also considered factors likely to affect immigration into the main industrial areas. While attractive living conditions exist for new skilled workers, Natal possesses the highest standard of education in the Republic. Medical services are advanced and extensive. Map 1E shows the major outdoor recreation facilities in the Province. The equitable climate is most conducive to sport, and the enjoyment of the beaches, sea and major Game Reserves in Zululand, the Drakensberg Mountains or the Midmar Lake which is nearer to the urban centres.

The future spatial pattern of industrial development will occur within the Pietermaritzburg - Durban axis, that is, within the Three Rivers Region. In later years development will partly disperse to the Richards Bay - Vryheid axis. In the Three Rivers Region, the economic expansion of the 1960's, has led to only a few industrial sites remaining at Durban (N.D.B. 1968). This in turn has stimulated industrial dispersal to the periphery, such as Pinetown or Hammersdale (which is 34 miles from the centre of Durban). Pietermaritzburg still has a large reservoir of industrial land for exploitation. The industrial dispersal has also encouraged the movement of the population. The Government's policy of decentralisation of industry, in order to improve the social conditions of the Bantu, offers considerable tax and financial incentives to industries locating in the Border Areas. Map 1D indicates the Border Areas throughout the Province and the Three Rivers Region. With the exception of an area to the east of Mooi River the Region contains Bantu Areas and Border Areas (that is within 10 miles of the Bantu Areas). This non-

Border area also falls within the Howick Sub-Region, Map 1.

The second major development Region is the Tugela Basin with Richards Bay (see Map 1). Thorrington-Smith (1960) outlines the proposals for the Tugela Basin. The proposed rail link between Richards Bay and Vryheid and thus to the Rand, will greatly stimulate development. The Development Board estimate that some one hundred million Rand will have been invested in the development of the harbour and Richards Bay by 1975. A large aluminium plant is ~~providing~~ *to provide* the initial stimulus and growth is expected to occur at an accelerating rate, as external economics come into play. Although the Tugela Basin holds out a high potential for industrial location in the long term, it is likely to remain rural and undeveloped in the short term. The urban and industrial development is, thus, likely to follow a pattern of nucleated disposal along the Pietermaritzburg - Durban axis and within the Three Rivers Region.

Map 1 shows the position of the Howick Sub-Region in relation to the Three Rivers Research Region. The Sub-Region lies in the north western portion of the Three Rivers Region and the south western extremity of the Tugela Basin Research Region. The Sub-Region possesses three characteristics which are immediately notable. Firstly it lies on the border to both the Tugela and Three Rivers Research Regions. Secondly, from the point of view of physical features, the Sub-Region contains part of five bio-climatic groups - out of the six groups which occur within the Three Rivers Region. Finally, the Howick Sub-Region is of interest as it contains the Midmar Lake, a recreation and water control area, lying to the north west of the Pietermaritzburg city.

This regional overview is intended as a background to the more detailed survey and analysis which follows in the application and testing of the ecological approach.

3.1. APPROACHES TO PHYSICAL PLANNING

Although ¹⁴homo sapiens lived some 200,000 years ago, it was only five and a half thousand years ago that the world's first cities arose, and large scale urbanisation began but a century ago. This explains the recent birth of the applied science of Urban and Regional Planning, in the era of the industrial city. (Stewart 1952, Sjoeborg 1967)

From these ancient civilisations the ordering and planning of towns and country may be traced. An example of rural agricultural organisation some four millennia ago is the Banawe rice-terraces in the Phillipines, which still rank as a remarkable feat of water-engineering (Bagwadi / 1966). The city of Ur found in the fertile crescent of the Middle East was amongst the world's first cities. An oval-shaped, walled city it displays an ordering of the land usage, with a Royal Cemetery dating back to 3500-3200 BC, a Royal Court, temples, and tightly packed residential areas. (Clerk 1960, Fletcher 1961). Another illustration in the late Bronze Age, some 4,000 years ago tells of a Polish town, which was "carefully laid out in the most orderly manner." Situated on a promontory it was enclosed by extensive natural and artificial defences. (Roe, 1970) ✓

While bearing in mind the ancient origins of Town and Regional Planning, this work is confined to the development of the discipline, since the turn of the century. Due to the recent birth of the discipline, and the dearth of literature on the schools of thought, an arbitrary division into five schools has been adopted. These schools of thought are namely:- the ecological approach; visionaries; practitioners; theorists of form; and finally socio-economic theories of behaviour.

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The practitioner is directed towards the solution of practical problems, and the implementation of the solution. The visionaries, on the other hand, provide the speculative theories, and often recommend a new start to urban settlement and planning. The visionaries often provide the broad framework or direction for the practitioners. The form or structural school, thought in terms of spatial patterns and designs to which the city should conform. They can be described as spatial visionaries. Fourthly the interaction and behavioural approach emphasises the socio-economic patterns. Here the underlying assumption is that form must fit the socio-economic requirements

and not vice versa. This school of thought resting upon the social sciences, was a major advance to the speculations of the visionaries and the formalists. Finally the ecological approach which arose from the biological sources consists of a synoptic approach resting upon the scientific method.

These ways of thought are not mutually exclusive, and are usually inter-related with other schools of thought. For example, the practitioners implement the visionaries' theories, or most visionaries have related their ideas to form garden cities and green belts.

The practitioners took the first steps to resolve the appalling slum conditions of the industrial age in Britain (Ashworth 1954). The excessive population growth urbanisation over-crowding and disease were associated with these slums (Clinnard 1970). Ashworth notes that the first town planning functions were in terms of public health. This was followed by attention to engineering questions such as services, water, sewage and roads. Because of the strength of the private builder it was some time before layout fell under the control of town planning. This evolution of planning also reflects in a simple way the priorities in planning, and also the components of planning.

Benevolo (1967) observed that the nature and aims of Town Planning have changed as the discipline grew, during the past century. As the aims changed, so did the problems to which town planning devoted its attention. The converse is also true; that as conditions change, new problems arise, but it usually takes time before society acts. Benevolo (1967) maintained that, "Even today town planning techniques invariably lags behind the events it is supposedly controlling, and it retains a strictly remedial character."

Many of the early visionaries were social reformers, moved by the plight of the worker and slum inhabitant. Whereas the practitioners had directed their attention to the solution of particular problems, the theoreticians were more prone to consider the wider inter-relationships. The latter also favoured the creation of new towns or a new beginning, free from the error of the past. Amongst the early visionaries noted by Benevolo were Owen, Fourier, and Salt. (Owen improved the social conditions at his mill at New Lanark.) Later visionaries were Geddes, Howard with his Garden City concept, Corbusier and Wright. Most of the visionaries or Utopians related their ideas to specific

physical patterns, e.g. Owen favoured the parallelogram, and Howard, concentric circles.

The formalists come from a long line. Stewart (1952) recorded that the architects in Utopia favoured a wide range of geometric patterns. Fritach favoured the six pointed star where modifications on the octagon were popular in the Middle Ages. Versailles is also an example of a complex geometric layout. Johnson (1967) noted the passing phases of fashions in urban design leading to the post industrial and colonial cities. He also quoted Radburn as an application of the garden city concept. The popular debate is between the linear city, star, core, hollow ring, satellite or disposed urban patterns. The geometric patterns are essentially unlimited.

Benevolo (1967) emphasised that town planning is not just physical patterns but is a vital factor in the creation of a changed society. Although Britain probably recognised the importance of cultural considerations earlier, the socio-economic factors came to the fore in the 1950's in the United States of America. The interaction school of thought interprets the human superstructure in terms of flow systems, communication and information theories, value systems, spatial economics and the relationship between the aspatial activity patterns and adaptations to space. Three leading proponents are Meier, Webber and Guttenberg.

The ecological approach is essentially a synoptic or holistic view to planning. It can be interpreted as an eclectic approach. Sir Patrick Geddes, who is often referred to as the founder of Town Planning, was a botanist, and proponent of the synoptic approach. In his book, 'Cities in Evolution' (Geddes 1915) he stated, "local character is attained.... only in the course of an adequate grasp and treatment of the whole environment, and in active sympathy with the essential and characteristic life of the place concerned." He introduced the concept of a comprehensive regional survey as a pre-requisite to planning and held a number of outstanding exhibitions to publicise his views and in order to take planning to the people (Broadman, 1944). In the sense that Geddes was ahead of his time, he was also a visionary.

The Chicago School of Sociology, under Parks and Burgess, introduced the concept of human-ecology in the 1930's. Reisman (1964) submits that despite its failings human ecology is the proposition which comes closest to a systematic theory of the city. The analogy between society and organism was drawn,

with the application of the biological concepts were applied to society. The interdependence of the biological features, was applied as a 'web of life' within which competition, symbiosis, invasion, succession and dynamic equilibrium was seen to pertain within the social realm. Burgess also formulated his famous concentric zone theory or urban structure. This study of organisations or groups of organisations in relation to their environment was also moved towards synthesis of concepts from the social and physical services. Reisman (1964) assessed this movement as providing some important techniques and insights, but fell short of a self contained theory.

In the past decade ecology has again come to the fore with the current international environmental awareness. McHarg (1969) redirected the planners towards the importance of physical and environmental factors in Urban and Regional Planning. McHarg (1969) makes a case for the ecological approach. He states, "In the quest for survival, success and fulfilment, the ecological view offers an invaluable insight. It shows the way for the man who would be the enzyme of the bio-sphere - its steward, enhancing the creative fit of man-environment, realising man's design with nature. The emphasis on the ecological approach has been applied by Phillips to planning problems (Phillips 1965, 1968, 1969, 1970B, 1970C are some recent examples). The movement towards environmental planning and ecology was discussed recently by Holling and Goldberg (1971) who pointed out the similarity between ecological and planning systems, in regard to independent systems, spatial linkages, historical succession, and non-linear structure. McLaughlin (1967), also proposed a greater alliance between planning and the systems approach on the basis of man's ecological setting."

3.2 METHOD

The method applied in this work has been adopted from Phillips (1969, 1970B) and McHarg (1969). In his work (1970B) he describes Ecology as the art and science of learning about the reciprocal relations of life and its environment. Ecology thus "comprises the responses of the organisms, from microbes to man, both as to their setting and one to the other; the reactions of any form of life upon its particular setting; and the nature and implications of the material and energy changes in the biotic communities constituted by plants, animals, and often, men." He also defines the eco-system as "an energy generated and energy transforming community of organisms integrated with its reciprocally controlled and controlling environment." (Phillips 1970B)

In utilising this ecological approach Phillips (1969) adopted a holistic approach in the correlation of the physical features into Bioclimatic Subregions or Groups. The Bioclimatic groups have been used as the basis for the physical survey. Phillips also isolated eight ecological and economic criteria for the classification and assessment of inherent suitability for future land uses - especially agriculture, forestry, and water conservation or use. The eight criteria are: (1) ~~Physical~~ features, (2) ~~Biological~~ features, (3) human features, (4) ~~Economic~~ factors, (5) physical and human infrastructure, (6) possible problems associated with development, (7) conservation and management of wild life, tourism and recreations, (8) aesthetic historic, scientific and any other aspects. These criteria have been utilised to indicate intrinsically suitable land uses, in accordance with McHarg's method (McHarg 1969). This method was applied to three problems: a sub-Regional physical survey, an open-space analysis and an industrial location analysis. *By whom?*

The Historical method, was used in order to obtain the reliable raw data. Almack (1930) states that "in Historical science the observer neither controls nor evaluates; his whole concern is to report what he observes with accuracy and fidelity" (without passing judgment on the events). Almack submits that the first step is to establish the validity of the sources - *is* the data genuine and valid? The criterion for validity and reliability may be expert witness. Reliability relates to whether the witness is dependable, or honest, and in a position to know the truth. Further, is the testimony reasonable and agrees with other evidence.

The normative *method* was employed in interpreting and assessing the data in order to arrive at proposals and recommendations. Almack notes that in the normative method the data and principles apply to values; and the facts and principles are likely to affect life situations. The normative method is employed in decision making as to what is the best choice. Validity is tested against accepted criteria, e.g. expert opinions, or by comparison with other test results. The reliability of the results are ascertained through retesting.

It should also be noted that the proposals do not constitute a plan, but are an examination for intrinsically suitable land uses. A plan would require the assessment of social goals and the consideration of society's method of implementing these goals

and the proposals. (McHarg 1969)

By whom? The approach used was to isolate the physical features and determine variables on a Regional and macro scale and then to sharpen the focus to a micro analysis, on a Sub-Regional and local scale. This has the advantage that variables are studied initially within a wider context, thus making the isolation of extrogenous variables more reliable in the micro view.

Finally, the basic data was obtained from interviews with local authorities, government officials and from published or private sources. The factual information so derived was recorded and later correlated to form the basis of this work. Maps of 1 : 18,000 and 1 : 50,000 scale were used for the field work, initial data recording, and final synthesis. The maps for the report were reduced to a smaller size, viz. 1 : 50,000 and 1 : 250,000 respectively.

CHAPTER 4

SURVEY OF PHYSICAL FEATURES

4.1 STATEMENT OF THE PROBLEM AND METHOD

The first problem or test for the ecological approach is to conduct a physical survey of the sub-region in order to establish the physical features and relationships. This overview is important for two reasons. Firstly a sound appreciation of the existing physical features is a pre-requisite to establishing sub-regional agricultural capability and intrinsic suitability for land uses within Howick and Lions River sub-region. The need for considering agricultural land uses arises from the Natal Town Planning Ordinance, No. 27 of 1949 as amended. In the schedule on matters to be dealt with by schemes, point 14 specifies, "land to be employed solely for agriculture and similar purposes, and the application thereto of differential rating."

The need for conducting a survey of physical features and intrinsic suitability has long been appreciated in Natal. Thorrrington-Smith, past Director to the Commission, makes the point in the foreword to N.I.W.R. (1967). He says, "the Natal Provincial Administration and its Town and Regional Planning Commission have always held that the planned development of any region is dependent on objective and scientific analysis of all the factors operating in that region. The preservation of natural resources and their development in the service of man can only be assured if their fundamental characteristics, and the natural processes which affect them, are closely studied and understood." This approach was also applied in his work, Thorrrington-Smith (1960).

The method adopted involved the consultation of scientific reports and theses for this sub-regional survey. The physical features are examined in terms of physiographic and bio-climatic characters. The former includes topography and drainage, geology, hydrology and a synthesis into physiographic regions. The bio-climatic features consider climate, vegetation, soils, and a synthesis into bio-climatic sub-regions.

The agricultural capabilities have been determined from Scotney (1970). The bio-climatic sub-regions, (Phillips (1969)) are briefly related to Scotney's ecological areas. Scotney's

agricultural capability rating and agricultural land use proposals are presented briefly. The survey thus proceeds from a consideration of the physical features to an assessment of the agricultural capability for Lions River Sub-Region.

4.2 SURVEY OF PHYSICAL FEATURES

4.2.1 INTRODUCTION

Particularly when the physical structure is examined, a broad vision is required. Physical features merge from one region into the next, from one age into another. The Lions River Sub-Region is only a small portion of the Three Rivers Region, which in turn forms part of the Province. The brief overview to the sub-region has thus been provided in the Regional Background in part I.

The most fundamental point in considering the physical features is the interaction and reaction between the physical factors. Even the dichotomy between physiographic and bioclimatic considerations is artificial, for example, climate is a major factor in shaping land forms. Thoman (1962) and Strahler (1965) provide a general introduction to physical features and their consequence to man and land use planning.

Thoman points out that man's economics, political units and his other creations are superimposed upon and dependent on a natural (physical and biological) environment. Change is a characteristic of this environment; sometimes it is rapid as with the removal of indigenous vegetation by man, or it may be very gradual as in the change of world land forms. Economically the natural environment is of importance to man as firstly it provides both physical and biological conditions within, and on which man's production, exchange, and consumption occur. Secondly the natural environment is a storehouse of source materials, resources that are ultimately consumed by man. Nearly every commodity that man has produced and consumed existed originally in the natural environment. Nature also provides nearly all the energy needed for economic activity. Further the physical and biological conditions may be favourable or unfavourable to the cultural superstructure; for example plains may be advantageous for production and agriculture but a liability in times of flood.

In discussing land forms, Thoman points out that land forms are composed of rocks which in turn are made up of minerals. The land forms are a result of the continuous action of the agents

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of ware chemicals, wind, water, or temperature, and sub-surface forces of upthrust, e.g. volcanic activity and earthquakes. He distinguishes four forms, namely plains, plateau³, hill country and mountains. Of these four, agriculture and manufacturing show a global preference for plains and hill country. Flat country also facilitates the transportation network.

Thoman also notes that rocks are primarily classified into three groups. Igneous rocks result from a direct cooling of molten material called magma. If this active magma reaches the surface, it later hardens to become an extrusive igneous rock, while on the other hand if the magma hardens while still underground it becomes an intrusive igneous rock. Secondly, sedimentary rocks are particles or materials which have been deposited and later hardened. Often chemical weathering, action of ice, glaciers or other agents erode the parent igneous rock. These sediments are reworked and supplemented by the vegetation, soil and climate to form a new material. Water formed sedimentary rock usually assumes a layered structure (as with shales, which predominate sedimentary rocks). Shales and sandstones are usually from mud or clay, compressed by other sediments, in waterways and water bodies. (Both the Ecca and Beaufort series of the Karroo system are sedimentary rocks). Finally metamorphic rocks are the outcome of changes in igneous and sedimentary rocks, from pressure and heat in the adjustment of the earth's crust. An introductory discussion may be had in both Strahler (1970) and Holmes (1944).

A few obvious implications of geomorphology are: the glacial erosion which formed the great lakes; whereas the Rhine Valley was formed by faulting and rifting; good natural harbours are often found along submerged coasts but lacking along emerged coasts. The mineral wealth of a country is of obvious value to planners, vide South Africa or, recently, Swaziland.

The river systems are directly related to the climate, which provided the precipitation; the topography and geology in which the river bed was formed. Topography and soil conditions in turn modify the rainfall, so that not all of it runs off into the rivers. An important factor here is the vegetation cover which reduces the shattering impact of the rain drops and thus prevents and mitigates soil erosion, (which is often the consequence of overgrazing and depletion of the vegetation cover). In the construction of dams, (for example Midmar and Albert Falls Dam) the rock type is important for the building of the dam walls;

the soil for the bed of the dam; and the erosion is important in determining the rate of siltation and impairment to a dam's capacity. Besides water for rural and urban use flood control is another, though expensive, function of dams. The sponges or vleis at the sources of many rivers are nature's method of regulating the water flow. Major dams are increasingly associated with recreation areas. (Robertson, 1970, Dasman, 1968).

The four basic elements of climate are temperature, humidity (including precipitation), pressure and winds. The climate has a marked interaction with vegetation and soils. There is an orderly pattern of climatic distribution in global and national scales. This pattern of ~~hotness, wetness~~ ^{heat} ~~moisture~~ (humidity), or rather climatic distribution is reflected in the vegetation distribution, as plants have specific climatic requirements. Land forms such as mountain ranges affect the climate. In the global pattern, climates may be classified into some thirteen main groups ranging from tropical rain forest to humid sub-tropical, to arid or desert. In discussing the humid sub-tropical climate in which Natal falls, Thoman locates this group as extending southwards from the tropic of Capricorn to approximately 40 degrees South. Although frost occurs in winter and its severity increases with altitude, the sub-tropical indicates a long growing period, and winters which are not harshly cold. Precipitation is regular and heavy, usually between 40 - 70 inches p.a. ~~Via~~ ^{through} evaporation and precipitation the climate maintains the hydrological cycle, and the flow of underground and surface water resources. Air circulation in urban areas, and along valleys, strongly influences the problems of air pollution - for example, at Howick and Pietermaritzburg. Climate is particularly important to the execution of three primary activities, agriculture, grazing and forestry.

Land vegetation, ~~as~~ ^{Thoman} points out, has been classified into three groups: forests; grasses; shrubs and tundras. Thoman states that very generally these respective three groups are associated with climates and soils which are moist; moist to dry; and very dry or cold. Broadly the higher the latitude the greater the transition from broadleaf-evergreen to deciduous to narrowleaf evergreen. The majority of natural grasslands can be classified into three broad categories: the savanna, the prairie, the steppe grass. The savanna is restricted to the low latitudes, and fringes the low latitude forests, except in Asia. Savanna grasses are noted for a height of four to

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twelve feet, with the tallest varieties found in the greater moisture of the low latitudes, fringing the deciduous forests, though occasionally tropical rain forest. Existing as individual perennials, the plant's stalks wither and die during the dry winters of the tropical savanna climate.

Eyre (1963) presents the biotic complex as an example of an ecosystem, with the interacting elements of climate, vegetation, fauna, and soils. ~~Firstly~~ he points out how climate exerts an influence or control on the distribution of plants, animals, and soils. Plants and animals have very specific climatic limitations within which they can thrive. Soils are determined by the weathering of the parent rock, organic decay and the degree of leaching. While the precipitation percolates down through the different layers of soil, the soluble mineral salts are removed, thus making the soil less fertile.

Climate in turn is profoundly influenced by the vegetation cover. The wind, temperature and humidity in the shade of a forest are quite different at a similar height above the ground in a savanna. The vegetation too is a crucial element of the fauna's habitat. Remove the habitat and the fauna must follow. The reciprocal relationship is the fauna's interaction on the vegetation; man, of course, is the major intruder and a crucial force in the biotic complex.

The soil reactions to the fauna may take the form of soil erosion resulting from diminished vegetation cover. The soil properties provide the food for, and limit the occurrence of biotic associations. In discussing soils, Strahler and Thoman make the point that soils are a dynamic body, resulting from the slow mixing of critical organic, humus, trace elements, other materials and minerals necessary to plant life. This mixing occurs as a result of the action of surface and underground water, the air, and myriads of microscopic and macroscopic creatures and plants. By determining precipitation and limiting biotic features, climate exerts a crucial influence on soil formation. This is reflected in the general correlation between global climatic and soil zones.

In considering soil properties, Strahler notes that soils are composed of organic materials, minerals, water and air. The size of the particles determine the soil texture, which is based on a triangular grading of clayey soils with a fine texture; sandy soils with coarse textures; and intermediate textures are loam (that is silts or a combination of sand and clay). The

arrangement of the soil particles constitute its structure. The soil's waterholding capacity is most important in determining its agricultural potential. The soil colour ranges from white to yellow, brown, grey, and to black. The colour may be an indication of humus content or acidity. Soil acidity is measured on a PH scale ranging from 1, maximum acidity, to 4, very strongly acid, 7, neutral, 10, strongly alkaline or base; and 14, maximum alkaline. The fertility of the soil refers to its content of nutrients, and finally productivity or capability relates to the soil capacity to yield specific crops under indefinite conditions of climate and cultivation.

elementary and not
intermediate
Besides soil classification according to acidity and alkalinity, soils may be classified by orders. Most soils are stratified, or lie in distinct layers. A profile is a vertical or cross section of the soil, which reveals four major layers or soil horizons. The top horizon is called an 'A' horizon and is some fifteen inches deep and constitutes the topsoil. The 'B' horizon is the subsoil, 'C' horizon is a layer of partly weathered, broken down parent rock and the 'D' horizon which consists of unmodified rock or parent material. Most zonal soils can be classified in terms of horizontal layers or horizons which coincide with areas of natural vegetation. Intra-zonal soils are dominated by the non-bio-climatic factors; that is parent material, land form, and time. An example of intra-zonal soils are the hydromorphic or saturated soils of vleis and bogs. Generally, zonal soils have poorly developed profiles of recently deposited materials such as silt, sand or allivium.

ps. Thoman continues: soil groups are classified on the basis of depth, colour, organic content, ~~PH~~ and other properties. In the sub-tropics, the red-yellow soils are the most common ~~to be~~ found mostly under deciduous ~~and~~ *forest* and conifers respectively. These soils occurring with copious moisture are usually badly leached, with most of the humus content removed. The soils are generally unproductive.

While the rain is weathering land forms, it is also forming different types of soils, and building up concentrations of mineral deposits. The parent rock initially influences the soil texture, which greatly affects the ability of the soil to absorb and hold moisture. This moisture is so essential to plant life. Climate, thus, not only acts directly on soils to form ice, wind, and water erosion, but also interacts on the vegetation covering, which affects the rate of soil erosion. Besides the crucial role

of soil in the biotic complex, a sound knowledge of soils will inform the planner of high capability agricultural areas, or suitable soils for highway engineering foundations, or septic tanks. These are everyday problems which the planner continually faces.

This section has specifically been written in a simple way in order to explain the general physical interrelationships, terms and implications for the planner, and in order to provide an introduction of some principles in physical planning to the layman. Although man's economic and cultural activities have been superimposed upon, and meshed into a physical structure, man can not disregard natural environment. So, too, land use or physical planning must rest upon a solid foundation of physical geography.

and books

"This is a summary"

4.3 PHYSIOGRAPHIC FEATURES

Phillips (1969) defines physiography as the study of the physical features of the earth : for example, mountains, escarpments, plains, valleys and other land forms.

4.3.1. TOPOGRAPHY

The general topography of the Sub-Region is shown on Map 2A. Moving from East to West, there is a corresponding rise in altitude. The lowest point, some 2,500 ft. (762 m) altitude is on the Umgeni River in the Pietermaritzburg bench land; while the highest point, over 6,000 ft. (1829 m) lies to the west, in the highlands which rise from 5,000 ft. (1524 m).

In general the rise in altitude is accompanied by a change in land form. Behind the city is the Pietermaritzburg escarpment which holds up headward erosion. The escarpment is clearly shown on Map 2C as the heavy line to the west of the city. Generally the terrain below 3,000 ft. comprises undulating foothills with wide river basins, as in the lower reaches of the Karkloof Valley and Pietermaritzburg basin, Map 2A. The topography becomes hilly and steep in the Midland area (4,000 - 5,000 ft.) (1219 - 1524 m). The Highland area, rising from about 5,000 ft. (1524 m) forms a semicircle, moving from above Karkloof in the East, past Nottingham Road on to the Inhluzani Mountain Range in the West. This semicircular highland relief, forms the 'main divide' watershed between the Tugela Basin and the Umgeni River catchment area. The divide is shown as dark dashed line on Map 2A. The Mooi River which runs north-east thus falls into the Tugela Basin side of the main divide. South of the Highlands and the main divide, the rivers all tend to drain in a south-easterly direction (as opposed to a north-easterly direction in the Tugela Basin). The most important river, the Umgeni, in turn comprises the Karkloof and the Lions Rivers as major tributaries.

Agriculture is considerably influenced by the topography, broken and hilly terrain, and land lying in rain shadow areas, i.e. to the leeward of major ridges, imposes an adverse restriction on agricultural potential. In general, a major rise in altitude corresponds to an increase in precipitation, and decrease in temperature, which in turn influence the agricultural capabilities of an area.

4.3.2. GEOLOGY

33
7 TRUSWELL?

An overview of the geology of Natal, as in Truswell (1970), shows that generally the province is split into the Karroo and the Cape Systems. This split occurs along an imaginary line running south-west from Kranskop, parallel with the coast, passing to the south-east of Pietermaritzburg. The ~~Sub-Region~~ falls to the west of this line. Moll (1965) points out that there are two theories; the fault theory and the monocline theory to explain this change in the geological structure of Natal. To the west of the monocline the structure is horizontal and comprises examples of the Eccca, Beaufort and Dwyka series of the Karroo System. To the east of the monocline or fault, there is an incline to the ocean which exposes the table mountain sandstone and shales of the Cape System.

Truswell (1970) states that though fossils are not common in the Karroo system, the fossils which have been found were land or fresh water forms, and indicate that the system ranges continuously in age from the Upper Carboniferous through Permian and Triassic into lower Turassic ages, i.e. extending from, say, 300 to 180 million years ago. (See Appendix 1, Geological time periods.) The succession consists predominantly of sandstones and shales, floored by a glacial tillite and roofed by basaltic lavas, in addition being riddled with sheets and dykes of dolorite related to the basalt.

Map 2B shows the geology of the Sub-Region as essentially comprising the Eccca and Beaufort Series, with a remnant of the Stormberg sediments in the south-west portion of the Sub-Region. A comparison of Maps 2A and 2B reveal that there is a strong correlation between altitude and geology, with the higher altitudes revealing the higher beds.

The Eccca Series, comprising shales and sandstones, is usually found below an altitude of 4,500 ft. (1372 m). The lowest stratum, which occurs at Hilton Road, comprises light coloured fine to coarse grained sandstones of the middle Eccca beds. Several bands of stronger sandstones separate the lower and upper Eccca shales. The middle Eccca rocks are predominantly blue-grey shales and sandstones, which are noted for the properties of water retention and resistance. The erodible upper Eccca shales produce the hilly landscape of the Howick to Nottingham Road Area (Turner 1967).

The triple Beaufort series follows conformably on the Eccca Series and lies between the altitudes of 4,500 ft. (1372 m) and 6,000 ft. (1829 m). The Beaufort is composed of a monotonous sequence of shales and mudstones with interbedded sandstones. The rocks of the lower group are characteristically the yellowish, fine to medium grained sandstones of complex mineral content (felspathic). The middle and upper beds are predominantly the bright red, maroon and purple mudstones. (Scotney 1970)

Truswell (1970) points out that the rocks of the Stormberg Series form the mountainous region of Lesotho and adjacent fringes. The Stormberg sediments are found in the southwesterly portion of the Sub-Region. The sediments are confined to the high peaks above 6000' ft. (1829 m) which form part of the great spurs extending from the Little Drakensberg. Rocks are pale coloured, coarse grained felspathic sandstone.

INTRUSIONS
Typical of the Karroo System, the strata are riddled with dolorites. The dolorite intrusions into both the Eccca and Beaufort series usually take the form of sills and dykes. Sills are concordant, that is they intruded parallel to the bedding : dykes are vertical. The vertical dykes are notably narrow, running for long distances, and are especially common to the west of Nottingham Road. The dolorite's resistance to weathering results in numerous elevated hills and ridges. The intrusive harder dolorite dykes and sills are seen in many of the waterfalls, especially the spectacular Howick Falls. The dolorite sills have also aged the river courses, for example, - the Lions River at Balgowan. Below the dolorite obstructions the rivers flow rapidly with high silt loads. Dolorite dykes often form the important key areas which lead to the hydromorphic bottom lands or vleis.

4.3.3 THE HYDROLOGY

Kokot and Middleton (1961) played an important role in the Committee which was appointed by the Commission to investigate the present and future requirements of the Umgeni River Catchment, and the published findings form the substance of the following hydrological information. Hydrological considerations are usually considered in terms of water resources and requirements.

As a water resource the Committee emphasised the importance of the Umgeni River System as amongst the best run off systems in the country. This followed from the combination of three factors: the relatively high run off; the absence of significant erosion

within the catchment; and the river's close proximity to the major urban centres in the province.

The Umgeni river rises near Spionkop, which lies to the west of the Sub-Region. Over its course of 160 miles the river falls over 6,000 ft. from its source to sea level. The catchment is roughly pear-shaped, with the ~~Sub-Region~~ located at the base of the pear, while most of the urban development (and water requirements) lie in the lower catchment, or the top of the pear.

The upper catchment lies approximately between the source of the river at Spionkop and Baynesdrift, on the Pietermaritzburg-Wartburg Road. Here the river flows through open valleys of no appreciable depth below the surrounding country. The sandstones and shales of the Beaufort Series and Ecca Series are rather soft and easily erodible. The dolorite intrusions on the other hand are much less erodible, and where the dolorite crosses the river, headward erosion has been retarded. The Committee also noted that in spite of an average gradient of nearly 40 ft. in the mile, the two major dolorite intrusions above Howick Falls and Albert Falls have resulted in long stretches with mean gradients below 9 ft. in one mile. The dolorite dykes or sills also provide good foundations for dam walls.

For the whole catchment, rainfall is high, and variability is low. This means that there is a constant threshold in the quantitative supply of the water resources.

N.I.W.R. (1967) Note that the first water user of any importance on the Umgeni River is the Borough of Howick. The Town Board pumps water from the river which is then purified before distribution. The Howick Rubber Factory also draws off water for use in the factory, most of which is returned downstream. Further, just below Howick the Umgeni water is degraded from Class II to Class III for a short stretch to the confluence with the Karkloof River resulting from faecal pollution. The institute also note in their plan for possible improved water quality that the Umgeni River below Howick should regain the Class II classification existing in the Umgeni above Howick. (Class II is the highest and most common classification awarded.) This faecal pollution can be easily treated. On the whole the quality of the Umgeni water is good with no serious organic or mineral pollution occurring. The saturation pH and stability index show that corrosive tendencies exist, though this aspect can be inexpensively treated.

The only completely reliable method of calculating water resources is by actual flow measurements, over periods of 15 to 20 years, at a number of points within the catchment. From the Committee's estimates, it may be calculated that the cumulative mean annual run off for the Lions River, Midmar and Howick Falls areas is roughly half of that for the whole catchment. If the ⁿAlbert Falls area is included, the figure rises to some three-quarters of the total.

The Committee also considered seven sites for possible dams, two of which are pertinent to the Study Region. The Midmar area was surveyed and two likely basins were considered. The lower basin is more favourable, with a width of nearly two miles submerging an immediate area of 900 acres. (See Map 2H.) The Committee noted that although the silting rate is slow, in time it may well be necessary to raise the dam's capacity above the mean annual run off, in order to fully utilise the sustained draught possible from the favourable position of the dam. Secondly, the Albert Falls site was noted as possessing a very low gradient of the river bed. A low wall would thus flood a considerable area, as may be seen on Map 5. The extent of the river bed rock above Albert Falls is likely to affect the type of dam wall built. Although evaporation is generally an important factor in considering the sustained draught and storage sites, the loss is not considered to be a significant factor in this case. It is interesting to note that the ratio of the dam wall and storage capacity in the lower Midmar and Albert Falls storage basins is very close to that obtained at the Vaal Dam. Subsequent to the Committee's Report, Midmar Dam has been built and Albert Falls Dam is in the process of being built. *constructed*

With regard to water requirements, the Committee found that the existing use of water, in 1960, was predominantly urban. (A rough approximation of water use, from the Committee's figures, is urban 60%, irrigation 10%, power 30%, and industrial 5%), some 14.5 and 77.5 million gallons per day, being used in the upper and lower catchments respectively, for 1960. The Committee also recognised that all categories of water use, within urban areas, is closely related to population size. Urban water consumption, thus, provides for increasing per capita personal water use, small industrial use, E.S.C.O.M., and large industrial use.

The Committee estimated that the population for the entire catchment would rise to 1.7 million by 1980 and 2.9 million by 2000 A.D. Scotney (1970) quotes a revision of this estimate to 3.1 million persons and a requirement of 360 million gallons per day, in 2000 A.D.

Scotney also points out that in relation to urban requirements, agricultural demand is insignificant. Resulting from the favourable climate, a large number of dams within the Sub-Region provide for irrigation requirements. He also points out that in some respects water management policy is still undecided, for example the vleis, tree planting and water use, especially near the Karkloof River. Conservation of the water resources in the Howick Sub-Region is, thus, of major importance, as the water requirements for Durban fall within the lower catchment area.

4.3.4 PHYSIOGRAPHIC REGIONS

Physiographic regions are delimited primarily according to criteria of uniform physiography, similarity of land forms, elevation and slope of surface. There is thus a close correlation of physiographic regions with relief and geological structure. Turner (1969) divides the Three Rivers Region, alone, into some fourteen different physiographic regions, and as such the study region is but a small fraction of the whole picture. Moving inland from the coast in a westerly direction, Turner notes the following six regions: the Coastal Belt, the the Tilted Blocks of the Table Mountain Sandstone, the Coastal Hinterland, Plateau blocks of Table Mountain Sandstone, the Valley of a Thousand Hills, and the Pietermaritzburg Benchland.

The Pietermaritzburg Benchland, as surveyed by a westerly movement is, thus, the first of Turner's regions to fall within the Sub-Region, as seen on Map 2C. The primary natural boundaries within the study region, as shown on Map 2C are :

- (1) The Richmond-Pietermaritzburg-Greytown escarpment,
- (2) the Karkloof escarpment,
- (3) the Swartkop range, and
- (4) the Impendle Plateau, with which the Swartkop range and Karkloof escarpment merge.

Turner defines the Pietermaritzburg Benchland as being bounded on the east by the Valley of a Thousand Hills, and on the west by the Pietermaritzburg escarpment and hilly country west of Richmond. In the Sub-Region, the Pietermaritzburg Benchland is based on the shales and sandstones of the Ecca series (Map 2B), rising generally to an altitude of 2000 ft. (610 m)

to 2500 ft. (760 m). Whereas the lower Ecca shales have been eroded to form the Pietermaritzburg Basin, the middle Ecca outcrops and hard Table Mountain sandstone have resulted in scarp formation. (Turner 1970)

The Pietermaritzburg escarpment (2) rises some 1200 ft. (361 m) behind the city. Turner (1969) states that on the south eastern aspects of the escarpments, the clayey layers often result in slippery conditions with landslides occurring. In drier situations, as on the northern aspect of the Umgeni valley or Otto's Bluff, the escarpment is hard and steep with rocks strewn on the lower slopes.

Within the Howick Study Area the physiographic regions have been sub-divided into smaller areas. (Turner 1970). The Howick Benchland on Map 2C, lying between the Karkloof and Pietermaritzburg scarps. The Midmar flats or peneplain (5) which falls gently towards the area now covered by Lake Midmar. The peneplain is bevelled across the Upper Ecca shales, with dolorite intrusions - notably at Howick Falls.

The rich Dargle valley (6) beyond the Karkloof scarp, falls within the Natal Midlands, and extends westwards to the Umgeni-poort escarpment. The erodable Upper Ecca shales produce the rolling landscape around Howick. Still on the Midlands ^{meandering?} some 4000 ft. (1219 m) to 6000 ft. (1829 m), the well wooded indigenous kloof and Podocarpus forest on the south facing slopes, leads to the benchland (8) lying below Fort Nottingham. The geological series on Map 2B shows this area as formed from the Beaufort series. Returning to the Howick Benchland and below the Karkloof escarpment, the Karkloof River meanders across (9) a flat flood plain which continues along the river valley to (1) the Pietermaritzburg Benchland and Albert Falls. The Umgeni River thus flows from the Impendhle plateau, through Beaufort to the Ecca Series in the Howick Benchland, falling 360 ft. (110 m) across a dolorite sill to flow into the Umgeni Valley or flat flood plain. (Turner 1970)

4.4 BIO-CLIMATIC FEATURES

4.4.1 CLIMATE

Not only is climate a most important factor in the distribution and nature of soils, but as Scotney (1970) states, it is the most important single factor affecting land use and determining agricultural potential. Macro-climatic characteristics may be used as a criterion in defining broad agricultural regions, while micro-climatic features, such as rain shadow areas are more important to planning as the intensity of the land use increases.

The rainfall distribution on Map 2F, follows physiographic features. Scotney's rainfall map shows the Umgeni Valley, below Howick Falls, as receiving the lowest rainfall in the Study Region (that is below 750 mm or 25.6 inches). Continuing up the Umgeni, the Merrivale valley, below Howick and including Midmar Lake, is also below 800 mm (31.5 inches). Scotney's 900 mm (35.4 inches) isobnet closely follows the 914 m (3000 ft.) contour on Map 2A. The third and largest rainfall area covering the centre and most of the Sub-Region is rainfall between the 900-1200 mm (or 35.4 to 47.2 inches). Scotney's fourth area of rainfall exceeding 1200 mm (or 47.2 inches), falls roughly on the Impendle plateau (area 4 on Map 2C); and the northerly area above and between the Karkloof River and the Umgeni Valley.

Rainfall characteristics are such that December and January are the wettest months, while the annual rainfall figures are noted for their range of variability. There is a very close correlation between rainfall and altitude. Precipitation in the form of mist is an important consideration above altitudes of 1220 m (4000 ft). Much of the Sub-Region falls within the Natal Mist belt (vide Map 2E/26). In summer mist often forms at the high altitudes, while in winter the cold air draining into the valleys often results in mist. Scotney notes that the mist, while increasing moisture and humidity, reduces evaporation. The low temperatures accompanying mist formation also reduce evaporation and thus ~~plant water loss~~ ^{transpiration}. Because of its water requirements the climax Podocarpus forest is a good indicator of moist conditions. The early summer is also noted for thunderstorms which are often accompanied by hail. The regular snow line is at approximately 1524 m (6000 ft). Snowfalls have been recorded throughout most of the region.

Stable
Sown

TABLE 1

THE SECTOR FROM WHICH THE WIND BLOWS MOST OFTEN AND THE PERCENTAGE FREQUENCY OF THAT WIND

	Sector	Frequency	Sector	Frequency	Sector	Frequency
	JANUARY		JULY		AVERAGE OVER YEAR	
CEDARA S 29°32' E 30°17' Alt. 1063m.	E+ESE+SE	42.4%	WSW+W+WNW	34.0%	E+ESE+SE	33.3%
LADYSMITH S 28°34' E 29°46' Alt. 1061m.	ENE+E+ESE	43.8%	W+WNW+NW	22.7%	ENE+E+ESE	29.4%
MISTLEY S 29°12' E 30°40' Alt. 975m.	ESE+SE+SSE	37.7%	WNW+NW+NNW	39.7%	ESE+SE+SSE	34.0%
PINTERMARITZBURG S 29°35' E 30°22' Alt. 684m.	E+ESE+SE	44.5%	E+ESE+SE	23.1%	E+ESE+SE	38.8%

The main factors affecting temperature in the Sub-Region are altitude, topography and oceanic influences. Scotney submits that the thermal lapse rate is similar to the common 1.6°C per 305 m (1000 ft). Low temperatures, resulting in frost, are common throughout the Sub-Region, including the lower altitudes. The drainage of the cold air into valleys is a major factor affecting the occurrence of frost. The period of active growth of the vegetation is usually determined by the first and last frosts, temperature and moisture conditions. This period is an important limitation on agricultural potential. The colder temperature at the high lying areas, as at Nottingham Road, reduces the growth period by four to six weeks. With this exception, the growth period for the Study Region is from the beginning of October to the beginning of May. Although the drier areas have considerably less frost, as at Howick and Merrivale, the moisture deficiency reduces the growth periods proportionally.

The main rain bearing winds according to Scotney, most frequently come from the South East (see Table 1). The hot dry berg winds blow from the west and north west sectors during July, August and September. Besides creating a fire hazard, the winds are critical to forest regeneration and impose a limitation on afforestation, especially pine timber production in the Highlands.

Scotney describes water balance as the relationship between precipitation and water need or potential evapotranspiration (which is the moisture lost to the atmosphere from a vegetation covered soil if it were constantly available in an optimum quality). The moisture index is thus calculated from the relationship between water need and precipitation.

Scotney defines his climate sub-regions or zones in terms of moisture and temperature conditions. The moisture properties of mean annual rainfall in millimetres (m.m.) and moisture index (m.i.) are used too as criteria for climatic subdivision into five groups. These are: humid, exceeding 900 m.m. and exceeding 20 m.i.); moist subhumid, rainfall between 800-900 mm and (m.i.) 5 to 20; slightly dry subhumid, 750-800 mm, and -5 to 5 (m.i.); dry subhumid, 700 - 750 mm, and moisture index -10 to -5. Finally very dry subhumid has rainfall below 750 mm and (m.i.) below -10.

The temperature conditions are sub-divided into three groups on the basis of mean annual temperature degrees centigrade (m.a.t.) and heat units degrees/day yearly (H.Uy), and from

October to March (H.U. o-m). These three temperature groups are: cool, temperatures below 15°C (m.a.t.), below 3500 (H.U.y) and 2500 (H.U. o-m); mild, between $15-18^{\circ}\text{C}$, exceeding 3500 (H.U.y) and 2500 (H.U.o-m); and warm with temperatures below 18°C (H.U.y) exceeding 4500 and (H.U.o-m) exceeding 3500.

According to this criteria Scotney subdivided the Howick Extension Area into climatic sub-regions. Very generally speaking these follow Scotney's ecological areas as defined in Map 2J. This is to be expected as climate and soils were the major parameters in defining the ecological areas. He describes the Highveld as humid and cool (eco-area 14); the Mist belt as humid and mild (eco-area 1B); the most northern portion of the area near Mooi River as moist subhumid and cool (eco-areas 2C) with eco-area 2D noted as slightly dry to dry subhumid and mostly cool; the Dargle valleys as moist subhumid and mild (eco-area 2A); the Midmar valley as slightly dry subhumid and mild (eco-area 2B) and finally the Umgeni gorge alone, as dry subhumid and mild to warm climate (eco-area 3B). The climatic and other factors were synthesised to form the ecological areas, which are discussed at the end of this Chapter in terms of agricultural capabilities and potential.

4.4.2 VEGETATION

Scotney (1970) supports the principle that vegetation reflects the environment, having been influenced by the conditions under which it developed. He emphasises the importance of fire as an important element of the environment. Little of the vegetation has escaped the effect of annual burning, usually between Autumn and early Spring. An additional human factor influencing the vegetation cover has been mismanagement. The effects may be detected in the secondary nature of much of the vegetation, encroachment of undesirable species and the diminishment of the forests.

The few main vegetation types found within the Howick Sub-Region are grasslands and savannas; ectonal grasslands (Odum, 1959 defines an ectone as a transition between two or more diverse communities, as for example between forest and grassland); valley vegetation and forest. In Scotney's (1970) work in which he studied the Howick Extension Area, he gives the following distribution of the types of vegetation : grassland and savanna 76%, ectonal grassland 16%, valley vegetation 5% and forests 3%. This serves as a guide to the vegetation distribution within the Sub-Region, with the proviso that Scotney's survey extended into

the Mooi River Valley conservation district and only to the tip of the Umgeni Valley. (For an approximation of his Survey area see Map 2D, and 1H)

The vegetation types, according to Moll (1965, 1967), which are found within the Sub-Region, are shown on Map 2E. The vegetation delimitation closely corresponds to Phillips (1969) on Map overlay 2G. The relationship of the terminology for the bioclimatic sub-regions and vegetation or agro-ecological area has been tabled in Appendix 3. In this context it is important to note that Scotney's vegetation types and distribution formed a significant parameter in determining his agro-ecological areas. (Map 2J) A comparison of Moll's and Scotney's classifications and definition of vegetation types thus follows according to the four main vegetation types.

Grasslands and savannas, are represented by Moll as Highland Grassland, on Map 2E. This largely coincides with that described by Scotney as Highland Sourveld (Eco-area 1A on overlay 2J). Scotney, however, includes the terrain between the Mooi River and the main divide to the Tugela and Umgeni catchments in his grouping Highland Sourveld. Moll, on the other hand, has shown this area as similar to that north of the Mooi River, that is as "Mist belt Themeda-Aristida Grassland."

Scotney describes the limits to his Highland Sourveld (approximately agro-ecological area 1A on Map 2J) as lying between 4800 ft (1463 m) and 6000 ft (1829 m) above sea level; and a mean annual rainfall of 850 mm to 1500 mm; and a mean annual temperature of 15°C. He also noted the regular occurrence of severe frosts.

The Mist belt Themeda-Aristida on Map 2E closely corresponds to Scotney's "Midlands Mist belt Grassland", agro-ecological area 1B on overlay 2J. (The only geographical discrepancy being of course the area across the Tugela main divide.) Scotney describes the altitudinal limits of the 'Midlands Mist belt' as between 3500 ft (1067 m) and 4800 ft (1463 m) mean annual rainfall between 900 to 1500 mm; and mists are very common. He also states that temperature conditions are milder than those existing in the Highland Sourveld.

It is notable that Scotney divides his 'Midlands Mist belt Grasslands' into two zones, on the basis of the primary and secondary nature of the vegetation. On Map 2J, Scotney's Midlands Mist belt Grasslands is closely resembled by agro-ecological area 1B, notably the two vegetation zones. The zones differ in the degree of invasion especially by Aristida-junciformis which has

By 44

usually resulted from veld mismanagement. The invasion of the Aristida junciformis has ^{caused} such widespread replacement of the ~~primary~~ Mist belt Themeda grassland that the latter is today observed only where adequate protection has been afforded. In the absence of fire the grassland develops to a climax community of mixed Podocarpus forest.

Further, Scotney's Moist tall Grassveld (ecological area 2B on overlay 2J) may be considered similar to the Acacia ~~Sieberana~~ ^X savanna on Map 2E. Scotney defines the mean annual rainfall as between 750 mm and 800 mm, with an altitudinal range of 3200 ft. (975 m) to 3500 ft. (1067 m). The abundance of the Acacia ~~Sieberana~~ ^X may be attributed to the milder climate. Today very little of the natural grassland remains, as most of the area is intensively farmed.

The second major grouping is the Ectonal (transitional) Grasslands. The area, on Map 2E, designated as 'Moist Transitional Themeda-Hyparrhenia Grassland' corresponds approximately with Scotney's Moist Grassland transitional to Midlands Mist belt; eco-area 2A on overlay 2J. As might be expected with a transitional area, since it attempts to describe an ill-defined vegetation, there is some discrepancy between the geographical boundaries of these two types. The major difference in delimitation occurs to the ~~North-East~~ of Howick, near the edge of the Umgeni Gorge and the relic of mixed Podocarpus forest.

Scotney describes his 'Moist Grassland transitional to Midlands Mist belt' (Eco-area 2M) as ectonal between the 'moist tall Grassveld' in the Merrivale Valley (eco-area 2B) and the 'Midlands Mistbelt grassland' (eco-area 1B). The commonest species are Hyparrhenia-hirta, Themeda triandra and Aristida junciformis. It should be noted that/ the agro-ecological areas on Map/overlay 2J are not exact replicas of his vegetation areas, agro-ecological areas can, ~~however~~, be taken as very good guides to Scotney's vegetation type areas.

The third major subdivision is into valley vegetation. Here the area contained in the gorges of the Mgeni River and Karkloof River is described as 'Dry valley scrub and woodland mosaic' on Map 2E. Scotney adopts the term 'mixed bush of the Mgeni gorge' for a similar area (eco-area 3B, overlay 2J). He describes Acacia Karroo and Acacia Nilotica as common on the steep north facing slopes with Hyparrhenia hirta and Aristida junciformis alongside Acacia Sieberiana on the moister south facing slopes.

A

Finally, the fourth subdivision is into forests. The forests ^{referred} indicated on Map 2E are the Mountain and Mistbelt mixed Podocarpus forests. Since the distribution of these forests has been taken from Scotney (1970) aided by Moll, they are identical to his mountain and Mistbelt mixed Podocarpus forests.

Scotney He recognises these evergreen Podocarpus forests as the climax communities for both the Highlands Sourveld and the Midlands Mistbelt. He describes these forests as mere remnants of previous far greater forests. Fire, graxing and over-exploitation have been the major determinants in reducing their distribution. These remnants are confined to the moist slopes and deep kloofs which afford protection from fire and hot berg winds. The total extent of the forests shown is some 3% of the Sub-Region.

This forest vegetation type may be broadly divided into two types. Firstly 'Mistbelt mixed Podocarpus forest with a near annual rainfall exceeding 1000 mm and an altitudinal range of 3500 ft. (1067 m) to 4500 ft. (1372 m). The second type is the mountain Podocarpus forest which is associated with low mean temperatures and a minimum altitudinal limit of 1372 m (4500 ft). This type is noted for its shorter trees, structurally simpler and florestically poorer forest in comparison with the Mistbelt mixed Podocarpus forest. The greatest distribution of these forests is to be found above the Karkloof River. Their conservation and recreation potential should thus be investigated, as these forests face extinction unless protected (Scotney 1970).

4.4.3 SOILS

Scotney (1970) undertook a most detailed and comprehensive survey and analysis of the soils in the Howick Extension Area. He used the scientific information to determine agricultural land use proposals for the Howick Extension Area, which for the greatest part overlaps with the Howick Sub-Region (as seen on Map 1F : Location of the Study Region).

Scotney emphasises that climate has an overriding influence on the formation and distribution of soils within the Sub-Region. The most striking example of climatic results is the leaching of the Upland soils by natural processes. (Leaching relates to the removable of soluble mineral salts from the upper layers or horizons of the soil, by percolating water. The outcome is to make the soils less fertile, with a very low base status.

Scotney divided the soils into five categories of leaching. Hardly leached soils are very limited, occurring with hot, dry

conditions, and thus severe retardation of the weathering process. Free salts have a high concentration throughout the profile and a high degree of structural development is usual. Slightly leached soils usually occur in the drier areas and lower slope position. Moderately leached soils are associated with appreciable breakdown of primary minerals through weathering. Scotney states that in the considerably leached soils, as the weathering process has been partly restricted, this has led to a slightly higher base status in these soils. Finally, highly leached soils are common under conditions of intense weathering, rapid removal of soluble minerals and a very low base status.

There are five major categories or classes into which soils may be placed: landscape groups, landscape position, major soil groups, soil association, soil series and soil phases.

The first category, landscape groups of soils, are the consequence of the physiographic-climatic features. The more local variations in climate, the greater the complexity of the soil distribution pattern. Landscapes characterised of highly leached soils are noted for a humid and mild to cool climate, rainfall above 900 mm (35 inches) and include the 'Highland grassland and Mistbelt Themeda-Aristida' on Map 2E, vegetation (bioclimatic Group 3 overlay 2G). Secondly, moderately leached landscapes were observed in moist subhumid to mild or dry subhumid and cool climates; annual rainfall ranges between 750 to 900 mm; (29.6 to 35.4 inches). Vegetation comprises moist Transitional Themeda-Hyparrhenia grassland and Acacia Sieberna Savanna, on Map 2E (or bioclimatic Group 6, Upland Mixed Scrub). Finally, moderately to slightly leached soil landscapes correspond to a mean annual rainfall below 750 mm. (29.6 inches) in a dry to very dry subhumid climate; megalitic and clay poor soils are present. This area probably includes the Umgeni Gorge (bioclimatic group 10, Riverine and lowland mixed scrub, on overlay 2G).

The second category or classification is landscape position, which is subdivided into uplands and bottomlands. Uplands are constituted by undulating, rolling, or hilly, though sometimes nearly level, areas which stretch away from, and rise well above the local drainage ways. Bottomlands comprise the leveller and nearly level areas along the local drainage ways. The bottomlands, thus, receive the runoff water from the adjacent uplands.

The third category is major soil groups, which are determined by the most striking morphological characteristic. Amongst

other parameters, the following are important. Colour, structure, consistence, effect of iron oxide segregation, clay alluviation, lime accumulation, gleying and the degree of leaching. Scotney recognises ten major soil groups, of which six are red and grey-brown partly leached upland soils, and four are claypan bottom-land soils.

Soil associations form the fourth category. Scotney records that this category is subdivided according to soils in a particular landscape which have formed contemporarily under similar climatic-physiographic conditions, usually originating from similar parent materials. The soils within an association are not necessarily closely related. Scotney also distinguished between 14 upland and 4 bottomland soil associations. Soil associations are named after the most important soil series in the association. The associations are also indicated by capital letters and arabic numerals, e.g. A1, B2. Subscript, ¹²powercase letters denote the soil phase: h records a humic phase (organic carbon is less than 5%); o denotes a shallow phase (depth of 10 to 20 inches); s reveals a slope phase (exceeding 8% slope); and x indicates sheet, and y gulley erosion phases (e.g. A2s or B1x).

The lowest and most important category in the soil classification is the soil series. Scotney quotes the soil survey staff in defining a soil series as "a collection of soil individuals essentially uniform in differing characteristics, and arrangement of genetic horizons." Within the limited range of properties pertaining to each series, Scotney detected 56 upland and 8 bottom-land series. Phases of the soil series were also observed to facilitate planning for soil management.

Having explained the five major soil categories, it is possible to relate the characteristics of the seven major soil associations, which occur within the Howick Extension Area. (A point to note on texture is that clayey and loamy soils exceed 35% clay and loam content respectively, with sandy soils exceeding 65% sand.)

The A1: Balmoral-Farmingham association has a clayey texture and belongs to the red, highly leached category of upland soils. This soil association constitutes approximately 20% of the upland area defined by Scotney as Highland Sourveld. (Agro-eco-area 1A overlay 2J: bioclimatic group 4, Highland mixed evergreen forest, wooded savanna on Map 2G). It also constitutes approximately 25% of the upland area of Scotney's Midlands Mistbelt (agro-eco-area 1B Map 2J, and bioclimatic group 3, Mistbelt overlay 2G).

The Balmoral-Farmingham association is noted by Scotney as possessing soils of a very high potential for intensive arable use, cash and fodder crops, vegetables and pasture, with afforestation on the steeper slopes. The association is well suited to intensive supplementary irrigation, but possesses a very low plant nutrient status with extreme acidity. Commonly found on steep slopes.

B1 : Farmhill-Griffin-Clovelly : this is a clayey soil association of the yellowish-brown, highly leached upland soils category. It covers approximately 65% and 75% of Scotney's Highland Sourveld, and Midlands Mistbelt areas as defined above. In this association the clayey soils have a low moderate potential for arable use, second rate potential for trees; with low plant nutrient status, moderate to high erosion hazards, and usually occurs on the steep slopes. The humic phase soils possess high potential for arable use, being best suited to the rotation of pasture, grasses, roots and potations; also suitable for cold resistant tree species; there is the danger of wind erosion after fairly long periods of cropping.

C1 : Katspruit-Dell association is only representative of the acid hydromorphic soils of the bottomlands. It constitutes about 85% and 55% of the bottomlands respectively located in Scotney's Highland Sourveld and Midlands Mistbelt (agro-eco-areas 1A, 1B : bioclimatic groups 4 and 3 respectively).

Scotney states that depending on the soil series this association is in isolated patches best left in a natural state; or is unsuitable for arable use, although it can be used for the production of permanent pasture. A characteristic of this bottomland soil is the very poor drainage with a high potential erosion hazard. The Ivanhoe series should be managed in relation to water conservation requirements.

D1 : Vimy-Shortlands is one of the three associations to fall under the category of red, considerably to moderately leached upland soils. The Vimy-Shortlands association constitutes 23% of the considerably/moderately leached upland soils of the Lions River Conservation District; and 7% of the considerably to moderately leached soils of the Mooi River district. In other words this is the most common association in the partially leached soils of the upland landscape position. Depending on the series, this association has stable soils of high potential for arable land use; pastures and trees (Vimy and Doveton), maize

fodder crops and grass leys (Msinga) and suitable for pasture, wheat, citrus and vegetables under irrigation (Shortlands).

D3 : Loskop-Rooikop association incorporates clayey to loamy soils with ferruginous mottles, and or concretions, soft to hard plinthite, of the red, considerably to moderately leached upland series.

E1 : Bergville-Avalon-Southwold association occurs in landscapes characterised by considerably to moderately leached soils, in the upland landscape position the soil horizons have typically grey colours. This upland association comprises clayey to loamy soils without ferruginous hardpans. The distribution of this association is wide, occupying : in Lions River some 33% of the considerably leached and 55% of the moderately leached upland soils; in Mooi River district it constitutes 76% of considerably to moderately leached upland soils. The series constituting this association may be divided into groups. Firstly soil series possessing a high potential for intensive land use, such as maize sorghums and soya beans for series possessing a second rare capability and suitable for afforestation. The main limitations are a fairly low plant nutrient and organic matter status; with a moderate erosion hazard rating.

L1 : Clays, loamy and sandy soils are characterised by the considerable variability in texture, depth and drainage. These soils fall under the category of bottomland soils common to all landscapes, being young series found in recent river alluvium. They occupy 11% and 43% respectively of Scotney's Highland Sourveld and Mist belt respectively. Scotney also regards the clayey soils as possessing a limited potential for arable use, and high potential for pasture, though drainage is poor with periodic flooding. The loamy soils, although periodic flooding also occurs, have high intensive arable production, ranging from pastures to vegetables. Sandy soils on the other hand are excessively drained with a low moisture capacity following; and have a moderately high potential for arable use.

Two types of erosion are found in the Howick Sub-Region. Sheet-erosion occurs when surface soil is gradually removed over a large area and is often associated with grass burning and overgrazing. Gully erosion, on the other hand, results from streams of water removing the soil to expose channels or gullies. Scotney suggests that sheet erosion in the Lions River District may be more serious than is evident, in which case the compacency of the farmers is to be viewed in a serious light.

In considering vleis Scotney defines them as bottomlands characterised by hydromorphic soils; aquatic reedswamp, sedge meadow; and hygrophilous grassland communities. He emphasised the importance of the safe and sagacious management of vleis in order to prevent their destruction and abuse, with the consequence of soil erosion and loss of flood water control.

Map 2E is a rated soils map prepared by Scotney and Ludorf. Although the scale of Map 2E is 1 : 250000, the original soil classification maps were at the scale 1 : 50000. The grading of the soils has taken into consideration all the factors presented in the foregoing paragraphs. The soils have been graded into four classes : eminently, moderately, marginally suitable , and soils unsuitable for agriculture. The unsuitable class includes land with slopes exceeding 15% (1:6:6), poor soils and Podocarpus forest areas.

On examining Map 2D : Soils, it will be seen that A grade or soils eminently suitable for agriculture are a rarity. Using overlay 2G, these A grade soils are seen to occur in the Mist belt about Cedara and near the Karkloof River; Upland mixed scrub and wooded savanna, group 6, in the Merrivale-Midmar Valley; and in the Highland wooded savanna, north east of Rosetta.

The soil classification may also be expressed in terms of Scotney's Agro-Ecological areas, Map/overlay 2J. The eminently suitable soils are to be found in Agro-Ecological areas, 2A and 2B especially, partly in 1B about Cedara and near the Karkloof River; and 1A north east of Rosetta. Further, Agro-Ecological area 3B, the Umgeni gorge is the smallest agro-eco area in his survey. The soil assessment on Map 2D shows the gorge as essentially unsuitable for agricultural land use. The Merrivale-Midmar Valley, (Scotney's ecological areas 2A and 2B) are essentially moderately suitable soils and to a lesser extent eminently suitable soils. In relation to Scotney's agro-eco areas, the Merrivale-Midmar Valley as a whole is primarily suited to agricultural land use, with only a little marginally suitable and unsuitable soils. Other locations of moderate suitability grouping are along the Karkloof River, and in the Highlands.

In conclusion, much of the best agricultural soils lie in the Mist belt and the Highveld, with its lateritic yellow soils. The topography is rolling and often hilly. Rainfall is high, 90001200 mm (35.4 - 47.2 inches). Merrivale-Midmar Valley and Cedara flats have a preponderance of good soils suitable for agriculture. These lateritic soils often have a top brown soil

layer. They have good water retention and absorbing characteristics, and can sustain intensive farming. The soils of the Howick Sub-Region have been discussed in more detail, as they are a critical parameter in determining agro-ecological areas, and agricultural capability, which follows in the next section.

4.4.4 SYNTHESIS : AGRICULTURAL CAPABILITY

In his detailed study of the Howick Extension area Scotney (1970) recorded examples of the inter-relationships of the physical features, which in turn influences the natural characteristics and agricultural potential of an area.

Scotney recognises climate as the overriding factor affecting vegetation and soils. He observed that conditions where the moisture index exceeded 20, correlated with highly leached soils (approximately agro-eco areas 1A and 1B in the Highveld and Mist belt on Map 2J). Climate has also influenced the distribution of vegetation, with the coincidence of climatic and independently determined vegetation zones. The different form and structure in the Highland sourveld and Mist belt reflect important temperature and other climatic variations. The climax Podocarpus forest occurring in the humid areas :

Vegetation and soils have a close correlation. Local edaphic climaxes are common. Impeded drainage, or waterlogging and soil texture are reflected in the biotic communities. The effect of vegetation on soil formation is seen, in turn, noted in the example of the Podocarpus forests. Scotney also observed the interplay of other physic factors, such as soil, slope, plant cover, rainfall intensity and wind velocity or erosion. Physiographic effects were also recorded. Where the topography was gently undulating, particularly in the Highveld, great uniformity of vegetation types was observed, while more palatable grasses were noted on the south facing aspects.

This correlation between the physical features is applicable in not only the local scale but also on a more general, overall scale. This general correlation of physical features was shown by Phillips (1969) who defined Bio-Climatic Sub-Regions or Groups for virtually all of Natal. The Bio-Climatic groups appearing within the Howick Sub-Region have been discussed, and are shown on Map 2G. (Appendix 4 gives the parameters in defining the groups.) The title of the group indicates the biotic potential.

The largest Bio-climatic group, in the Howick-Sub-Region, is Group 4. Highland to Sub-montane forest, short forest and

Woodland Savanna : humid to subhumid. The Highland, group 4, is located between the altitudes of 4500 to 6000 ft. (1372 to 1981 m) with the appropriate concomitant parameters. The second largest group in the Sub-Region is group Mistbelt, Evergreen Forest, Upland Evergreen Forest and Wooded Savanna : (humid to subhumid) . Occurring at lower altitudes, 3000 to 4500 ft. (915 to 1372 m) on Map 2G, lying within the Mist belt is the Midmar-Merrivale Valley and the Umgeni gorge. The Midmar-Merrivale Valley is group 6, Upland Mixed Scrub and Wooded Savanna, moister faciation (humid to subhumid). The Umgeni gorge on the other hand is much dryer and at a lower altitude. The Umgeni and Karkloof gorges and valley occurs in Group 10, Sub-arid Riverine and Lowland Thicket and Wooded Savanna. The altitude range for group 10 is 500 -1500-3000 ft. (152/457 - 915m). This classification into Bioclimatic Groups is interpreted again in open space survey and analyses in Chapter 5.

Within this broader Bioclimatic Grouping, Scotney defined his Agro-ecological Areas, which are shown on Map 2J. Generally Scotney's Agro-ecological Area 1A correlates to Phillips Highland Savanna, Group 4; eco-area 1B coincides to the Midlands Mistbelt savanna, group 3; whereas eco-areas 2A and 2B relate to Bioclimatic Group 6, Upland Wooded Savanna; and finally, ecological Area 3B correlates to Sub-arid Riverine and Lowland Thicket Group 10. (This correlation may be seen on Maps/overlays 2G and 2J.)

The concept of ecological optimum relates to consistent high productivity in particular areas, where the form of agriculture is said to be in harmony or balance with the environment. Scotney's ecological areas are a synthesis and grouping of the physical features, using such factors as climate, soils, climax communities, indicative vegetation and physiography. He also utilises a 5 point use capability rating : 1, very high; 2, high; 3, moderate; 4, low; and 5, very low. He also distinguishes between intensive, semi-intensive and extensive cultivation. Generally, intensive cultivation occurs where cultivation is possible or fodder crops and dairy are combined. Semi-intensive agriculture is associated with areas where both stock raising and cultivation of crops are possible; extensive agriculture is confined to non-arable areas suitable to raising stock.

Scotney's ecological areas 1A and 1B are defined as possessing substantial moisture surplus exceeding 20. Consequently the upland soils are highly leached, of a low plant nutrient status, and are usually a low erosion hazard. The climax community is the Podocarpus forest. The areas 1A and 1B are distinguished on the basis of altitude, temperature, soil, and vegetation types. Together areas 1A and 1B occupy nearly 75% of Scotney's survey area.

Ecological area 1A, as seen on Map 2J, occurs above the altitude of 4800 ft. (1463 m). The major Upland series are A and B with the Balmoral, Farningham, Hutton, Griffin, Cleveland, Clovelly, Oatsdale and Mispah Series dominant. In the bottom-lands the Ivanhoe and Katspruit Series of the C1 association are important. The vegetation is typically Highland Sourveld or Highland Grassland with Montane Podocarpus forest. Area 1A is excessively rocky and contains steep slopes, thus excluding arable agriculture in these locations. Main limitations are the special treatment required by many of the soils; with low fertility; low temperature and steep and rugged terrain.

The ecological Area 1A has a ^{from} ~~secondate~~ potential rating. Here Scotney proposes intensive fresh milk dairy, cash and horticultural crops as the main lines about Nottingham Road, and Beef and Sheep as main lines in the capability subareas in the southerly and northerly portions of the ecological area. The eco-area has a high rating for maize and timber. Afforestation was recommended for the non-arable areas, by Scotney in his Agricultural Master Plan. The eco-area also possesses a high potential for recreation and wildlife preservation, particularly fish culture. On Map 2J, Scotney proposes certain areas as inherently suitable for recreation and conservation:- 6G, (Normandie Nature Reserve, on the south western border of the ~~Survey~~) and 6F (Fort Nottingham Forest Reserve, which is ~~in~~ ^{on} public ownership).

State land

Ecological Area 1B lies in the Mist belt and as defined by Scotney occurs: between the altitudes of 3500 to 4800 Ft. (1066 - 1463 m), with a humid and mild climate. A greater preponderance of heavy textured soils (e.g. Farm Hill Series); with Mist belt mixed Podocarpus forest as the biotic climax and secondary Aristida junciformis grassland the predominating vegetation type. The loamy and sandy soils are isolated to a small area above the Umgeni-Karkloof Gorge, where middle Ecca sandstone is exposed. The overall south easterly aspect, lower altitude and broken topography distinguish it from ecological area 1A.

Scotney considers eco-area 1B to be of first rate potential. The land thus possesses very high potential for intensive agriculture in a wide range of crops. Non arable land is suitable for afforestation or permanent cultivated pastures. Eco-area 1B also has a use capacity rating of 1 : (that is very high) for maize, timber and wild life. Limitations are the hilly topography and the low plant nutrient status of the soils. Scotney considers this eco-area to be suited to the following main lines. Very intensive fresh milk on pasture, timber, cash and horticultural crops. In the capability sub areas to the north, below the Karkloof forests, and the southern portion, Scotney advocates timber and breeding weaners as the main lines for both sub-areas. The Karkloof area is even better, having an exceptionally high potential. The capability classification reveals three areas as intrinsically suitable to wild life in 6A (the Karkloof Podocarpus forest, in the northwestern portion), 6B, (Karkloof River falls and sanctuary with adjacent Podocarpus forest), and 6E (Maritzdaal forest, lying on the western border of the eco-area).

Scotney's second division of ecological areas, 2A, 2B, 2C and 2D are located about the Midmar-Merrivale valley and to the north of the Howick Sub-Region, along the Mooi River, falling within Phillips' Bioclimatic Group 6. Scotney observed that this category is characterised by a lower moisture index, and a two month period of moisture deficiency, which have affected both the vegetation and soil properties. The vegetation is predominantly ectonal grasslands and moist faciations of the Tall Grass Veld, Upland Mixed Scrub and Wooded Savanna, Phillips' Bioclimatic Group 6 (overlay 2G and Map 2J. Phillips (1969), on the other hand has included all the four sub-divisions which Scotney has in Eco-area 2A to 2D, within his Group 6: upland

Mixed Scrub and Wooded Savanna. Scotney also pointed out that the interrupted leaching process is reflected in a high base status and the strong structural development of many of the soils.

Scotney's eco-area 2A, is the transitional zone about the Midmar-Merrivale valley (Map 2J). It lies between an altitude of 1066 m (3500 ft.) and 1219 m (4000 ft.); it incorporates Cedara, Howick and Tweedie (Map 2J, 1F), and extends up the Umgeni and Lions River valleys above Midmar. Moll describes the vegetation as Moist Transitional Themeda Hyparrhenia Grassland. Elements of the adjacent vegetation zones are thus present, that is, the moist Tall Grassveld vegetation, (Scotney) or Acacia Sieberana, and the Mist belt Themeda Aristida Grassland vegetation with a scrub forest and wooded savanna climax community. Scotney recorded the topography as undulating and hilly with some 45% of this Eco-area unsuitable for intensive arable use. The climate is moist subhumid and mild with the annual rainfall mostly occurring between 850 to 900 mm. In the Upland soils the D3: Loskop-Rooikop and D: Vimy-Shortlands and E1: Bergville-Avalon-Southwold associations predominate.

Scotney awards a 2nd rate potential, land use capability rating to Eco-Area 2A. (The Uplands Eco Area 1A, also received a 2nd rate potential classification). The land thus possesses a high potential for intensive agriculture, especially arable production. The main limitations are a moisture deficiency in the climate, inherent low soil fertility and topographical features - the Swartkop escarpment lies to the south and terrain to the north of Howick is very hilly. Scotney's agricultural master plan shows that with the exception of timber, the main lines above Midmar are the same as in eco-areas 1A and 1B (i.e. very intensive fresh milk on pasture, cash and horticultural crops). To the south and east of Midmar Lake, semi-intensive farming is recommended. Recommended use is essentially the same as for the Mist belt, but with timber a subsidiary line.

Scotney's ecological area 2B located in the Midmar Valley, is surrounded by the transitional eco-area 2A. It lies between the altitudes of 975 m (3200 ft) and 1066 m (3500 ft.) with a gently undulating and hilly topography. The climate varies from moist to slightly dry subhumid and mild. The rainfall, which varies from 750 to 850 mm, is influenced by the rain shadow effect from the neighbouring Swartkop range. Scotney states that the area ^{falls} below the mistline with frosts occurring between May and September. The upland soils are dominated by the E1: Bergville-

Avalon-Southwold association, with D1: Vimy-Shortlands association also important. Scotney recorded that the characteristics of the upland soils were poor drainage, ferruginous hardpan and a moderate erosion potential. Moll recorded the Midmar Valley vegetation as Acacia-Sieberana (Map 2E) Savanna, and Phillips classified this area biotic climax vegetation as Upland Mixed Scrub and Wooded Savanna: Group 6 (Map 2E).

With the exception of the portion to the north of Midmar, as mentioned previously in eco-area 2A, Scotney's grouping for eco-area 2 has a semi-intensive landuse capability of intensive use in the Mist belt and Upland. Map 2J shows eco-area 2B, as possessing a third class capability rating. The major limitations are a moisture deficiency and the physical limitations to the soil, although the area is ecologically suited to extensive farming. Scotney recommends intensive farming or, intensive fresh milk on summer pasture with fodder and fodder crops as the main agricultueal lines, bearing in mind the proximity to markets. This area possesses an important recreation resource in the form of Midmar Lake (noted as 6D on Map 2J). Scotney awards this a first class rating (very high) for recreation. He has taken into consideration the scenic aspects, biological productivity and wild life potential.

Eco-Areas 2C and 2D conclude the second category. These two areas are found to the south and east of Mooi River and occur between the altitudes of 1219-1371-1463m (4000-4500-4800 ft). The climate ranges from moist subhumid and cool in eco-area 2C to slightly dry to dry subhumid and mostly cool in Eco-Area 2D. The rainfall decreases, being mostly below 850 mm and 750 mm in Eco-Areas 2C and 2D respectively. In both areas the E1: Bergville-Avalon-Southwold association is most widespread. The vegetation varies from Scotney's Upland sourveld to the cool dry Ectonal Grasslands (Moll's Moist Transitional Themeda Hyparrhenia Grassland). The main limitations to agricultural potential are moisture deficiency and physical limitations to the soil. Scotney gives both Eco-Areas a third class agricultural capability rating, recommending intensive fresh milk on summer pasture and fodder crops as the main lines in Eco-Area 2C; with steer fattening, mutton and wool on natural grassland, cash and horticultural crops in Eco-Area 2D.

Eco Area 3D is the last of Scotney's ecological areas to occur within the Howick Sub-Region. He defines the distinguishing features of this area as including the warm-dry areas, with a distinct water deficiency, commencing in Autumn and lasting for five to seven months. The climate is very dry subhumid and very warm. Mean annual rainfall is below 700 mm and is noted for high maximum Summer temperatures and low minimum night temperatures in Winter. The altitude lies between 619-914 m (2000-3000 ft.) on map 2A. Moll, on Map 4E, defined the area as containing dry valley scrub and woodland mosaic vegetation. Phillips, on Map 2G, gave the biotic climax as Subarid Riverine and Lowland, Mixed Scrub and Wooded Savanna: group 10. Scotney noted that the vegetation comprises Acacia Karroo-A.nilotica thornveld, which poses an agricultural problem. The head of the Umgeni and Karkloof Gorges has very steep sides and a narrow valley, which widens out as one moves into a lower portion of the Umgeni River, about Albert Falls.

Scotney states that the critical parameter, distinguishing Groups 2 and 3, is the presence of claypan and marginal soils, with generally a high erosion hazard potential. The upland soils are mainly F1: Escourt-Bluebank association. Scotney gave this eco-area his lowest capability classification i.e. 5th rate or very low potential for intensive use. The eco-area is accordingly classified for extensive agriculture, such as beef, which is based on the natural veld. Scotney, however, awards this eco-area a low, class 4, rating for recreation, and a very low rating, class 5, for wild life. The wild life rating has been based on the potential of the land to produce a variety of vegetation covers, and thus a variety of habitats for different species of fauna.

4.5 CONCLUSION

This chapter has conducted a physical survey of the Howick Sub-Region as an essential component of the ecological approach. The main principles and interrelationships of physical features were discussed in general, and supported from the results of the survey in the Sub-Region by Scotney (1970). The critical physical variables were interpreted in terms of physiographic and bioclimatic groupings. The survey also revealed the interdependence of these variables in the form of action, co-action, and reaction one upon another.

The survey also attempted to isolate the main physical features of the Sub-Region and so provide a foundation of knowledge, on the physical structure, upon and within which the human or cultural structure may be developed. These physical features were grouped together in five Bioclimatic Sub-regions or Groups, according to Phillips (1969), on Map 2G. A high correlation occurred between the five Bioclimatic Groups and major ecological areas which Scotney delimited to determine agricultural capability.

The northern portion of the Sub-Region was contained in the Highland Podocarpus Mixed Evergreen, Forest, Highland Evergreen Scrub and Wooded Savanna. This Bioclimatic Group, number 4, has secondclass agricultural rating and is suitable for intensive agriculture. The Midlands Mistbelt, Group 3, lies at a lower altitude and received a firstclass agricultural rating. Its biotic potential is evergreen forest, upland green forest, short forest and wooded Savanna. Occurring near Mool River and Midmar Valley is Group B6: Upland Mixed Scrub and Wooded Savanna (Moister Faciation). This Group received a third and second class agricultural rating. Group 10: Subarid Riverine and Lowland Mixed Scrub and Wooded Savanna, occurred within the Umgeni Karkloof Gorges and valley. The agricultural rating was very low or 5th rate potential. The final Bioclimatic Group (2) was not agriculturally rated as this lies predominantly within the Pietermaritzburg urban sphere, and lies outside the Howick Extension Area. This final Group was the coast Hinterland, Evergreen Forest, Short Forest, Bush and Wooded Savanna. The Midlands Mist belt, thus, has the highest agricultural potential and the Umgeni Gorge the lowest potential. The seven major areas within the Sub-Region (as shown on Map 2J, Agro-Ecology) for nature conservation were also isolated for further investigation.

CHAPTER 5CONSERVATION AND RECREATION5.1 OUTLINE OF THE PROBLEM AND METHOD

Arising from a prior planning study of the Tweedie - Howick area, the need was recognised for a study covering a wider terrain and field of reference.

The problem thus posed for this study or test is twofold :

- (1) to consider the public need for outdoor recreation areas, nature and game parks, in the form of a general motivation; ✓
- (2) to examine or survey the area between Howick and Pietermaritzburg, in order to submit proposals on prime areas for conservation and recreation. ✓

The problem may be viewed as providing green open space^Δ for urban needs, recreation and tourist requirements. In towns or small cities, areas of semi-natural parks, public gardens and river areas are usually within walking distance of the urban dweller and worker. As the post industrial city has grown in size and population even to cover regions, the trend has been for the highest population densities to be located at the city centre, farthest from woodlands and open spaces. One solution to this problem is to delimit a geometric ring about the city, for example, London's Greenbelt. Another approach is to weave interlinked green wedges, patches and ribbons into the fabric of the city. This green space system would be based on the physiographic features. Such a system is also designed to break up the city into districts or suburbs, while providing accessible and visual satisfaction. This latter approach has been developed by McHarg (1969) and applied to a number of problems with success.

The method adopted in the first sub-problem has been to adopt a synoptic approach to the question of the need for conservation and recreation areas by considering physical, social and economic aspects. The question (is) viewed first from the point of view of conservation in relation to the eco-system, natural resources and planning. This (was) followed by considering recreation in terms of psychological needs and pathological consequences. Finally the economic aspects of the rise in disposable per capita income, leisure and tourism in relation to recreation and conservation, (are) discussed. This section essentially relies on literature sources for the information.

The second sub-problem is the identification of prominent

conservation and recreation areas in the Howick Study Area, that is, between Howick and Pietermaritzburg. The method adopted was to first survey the physical features with reference to Phillips' (1969) Bio-climatic Sub-Regions and Mc. Harg's (1969) method of physiographic determinism. McHarge proceeds by firstly surveying the terrain for natural processes areas working to enhance the benefits to man, and secondly, for areas hostile to urban development. Seven natural processes are identified, which indicate an area as intrinsically suitable for conservation or recreation.

After surveying the physical features, the second step is to briefly survey the socio-economic factors. Finally a synthesis unites the two steps, in the form of proposals and recommendations. This method of considering the physical, sociological and economic factors is drawn from both McCarthy (1969) and Phillips (1969).

Ecosystem

5.2 GENERAL MOTIVATION

5.2.1 SOME BASIC PRINCIPLES RELATING TO NATURE CONSERVATION

A. THE ECO-SYSTEM

Before conservation can be implemented, it is necessary to have a clear idea about the object or nature which is to be conserved. Living or biotic organisms, and the non-living abiotic environment are inseparably mutually dependent upon each other. A continuous exchange of stimuli in cause and effect relationships exist between the biotic organisms and the abiotic environment. An ecosystem is any aspect of nature where living organisms and non living substances occur and an exchange of material between the living and non living environment occurs. Odum (1959) and Whitaker (1970) make the following points:

Firstly, one eco-system has four main components :- the abiotic substances, basic organic and inorganic elements of the environment; the producers - i.e. primarily green plants which can produce food from simple inorganic matter; consumers/macro consumers, mainly animals which eat organic material; decomposers or micro consumers are mainly bacteria which break down the complex composition of the dead protoplasm; some absorb, others release.

Further, the basis of the exchange between the physical-chemical (Abiotic) environment and biotic groups, lies in the flow of transferred energy, and in the flow of food from producer to consumer. Certain foodstuffs are in turn released, through the working of the decomposers, which creates further potential for re-use by the producer - and a feeding cycle begins.

Finally, although it is generally known that the physical environmental factors control the activities of the living organisms, it is not always realised that the living organisms in turn influence the physical environment. Thus the chemical content of the sea and seabed is mainly determined by the activities of the sea organisms. Plants which grow on dunes build a soil which differs radically from the original soil matter. So, too, the composition of our atmosphere is determined by organisms.

B. THE ECO-SYSTEM AND CONSERVATION

Often the word 'conservation' is used in the sense of 'preservation', as if it is a static process which ensures that something is kept or remains for later. The essence of good

conservation management according to Cox (1969) and Van Dyne (1969) is to ensure a continuous production of plants, animals and materials, through the maintenance of a balanced cycle of 'harvest' and renewal. A balanced eco-system is where the mutual effect between the elements of the system reach an optimum. This balance will differ considerably with different systems, in accordance with the difference in the biotic and abiotic elements. ??
f1? They made the point that good conservation induces and maintains a balanced ecological system; not excessive cattle at the expense of the vegetation, not an intensive utilisation of natural bush at the cost of certain animals and plants. So too, a "no Fishing" sign can be worse conservation than a management plan which makes provision for the removal of surplus fish populations. The principle of the eco-system is the most basic principle of conservation.

According to this basic principle, other aspects of conservation are also managed, e.g. wildlife, natural vegetation, landscaping and recreation. They submit that in the long term there can be no better economic policy than the conservation of an ecological balance. Perhaps the most difficult aspect of conservation is to induce the general public to appreciate that humanity forms part of a complex environment, which must be studied and applied in its whole, in all its facets, and not on a basis of isolated projects; and that the objective of conservation is not just "in everyone's interest", or in the public interest, but that it is also of personal economic importance - for the natural resources form an integral part of the eco-system. (Dasman, 1968)

C. THE NATURAL RESOURCE SYSTEM AND MAN

A natural resource eco-system is an integrated eco-system i.e. amongst other things the system is of direct value, and benefit to man. The product may be biological as in the case of bushes, agricultural products, fish and animals, physical as in the case of water, air, earth or both. In all cases the distinctive characteristic of a natural resource-eco-system is that man has a direct involvement in the complex ecological relationships. (Kormandy, 1969 and Cox, 1969)

Thus man, too, takes his place in the ecological system - even if it is primarily in the roll of consumer, man has the paradoxical ability to expand his civilisation, in order to meet his daily needs, by destroying eco-systems. In this process

of destruction it is essential that examples of the unaltered eco-system be preserved as scientific controls or witness areas. This also enables man to evaluate his direction of advance or regression.

Everywhere, due to his action, (man) has caused various defects and ecological imbalances and to the disadvantage of his position within the eco-system. Destruction of the soil is a consequence of mis-utilisation - pollution of water and air, and over-population - certainly three important questions of our age. It is precisely man's ability to change the eco-system, which holds out the possibility that man will overcome his problems. If he does not succeed, perhaps some day a future evolutionary product will look back to man, as man looks at the Dinosaur's inability to adapt to his environment - and in the case of mankind, an environment which he has created. (Knight, 1965 Van Dyne, 1969.)

D. TOWN AND REGIONAL PLANNING'S ROLE

Technological man caught in his spiral needs of greater production for accelerating populations has turned a blind eye to environmental deterioration. The urban dweller can no longer regard himself as outside the eco-system. The hazards of environmental deterioration strike through :

- cumulative poisons, from pesticides;
- urban overcrowding;
- inadequate transportation systems;
- waste disposal; and
- water and air pollutions. (Johnson, 1970)

As Town and Regional Planning's function is not restricted to urban spatial arrangements, but is concerned with the satisfaction of man's physical and spiritual needs, any aspect of environmental deterioration is of great importance. Of the five main environmental hazards which are of fundamental importance, water and air pollution is considered.

Industrial and vehicular effluents are the main contaminators of the atmosphere. On a global scale Darling (1970) looks at the equatorial jungles to maintain our (a)biotic atmospheric balance. The need to have large areas of vegetational cover is even greater in the dense urban areas where smog and air pollution become unbearable. Green lungs or visual relief systems are a physical necessity for the fumefilled concrete jungle. But the green space system also tends to man's spiritual needs to be alone with himself, nature, or his creator.

So too, the view of watercourses as handy effluent and sewerage removal channels, has had to be revised in areas of urban concentrations. The death of Lake Erie is a stunning example, but with the introduction of effluent purifications requirements, streams and water concentrations may once again contribute towards the satisfaction of man's physical and recreational needs. (Charlier, 1969.)

The view of man, as an element in the dynamic eco-system emphasises the physical requirement of maintaining extensive green areas or visual relief systems to maintain the atmospheric equilibrium. The preservation of nature and game reserves as examples of ecological equilibria and of our physical heritage is essential. Unhindered the economic and technological ravages of the tractor and gun will leave little beauty for those to come.

5.2.2 RECREATION

A. SPIRITUAL MAN AND THE ECO-SYSTEM

Recreating man in these physical and spiritual elements is an incredible challenge. Not only does his physical biotic structure form part of the eco-system, but a holistic view must also be applied to his psychological structure and needs.

Throughout the world man's historical way of life and rhythm has changed drastically with urbanisation. What is but a brief moment in his historical evolution, man has to adjust to incredible population concentrations with ensuing hazards. In the ancient world one spoke of great cities in terms of hundreds of thousands of souls; today the scale is in terms of tens of millions. In his new book Ardrey (1970) explores the sociological and psychological consequences of ever packing more and more people on top of one another. Antheps within skyscrapers the modern city is expanding structurally, but at what social cost? Ardrey notes considerable deterioration of behaviour patterns in animals under conditions of increasing population density. Even fundamental institutional behaviour patterns have been found to deteriorate.

Against this background/^{cf} psychological and social illness, the function of recreation takes on vital importance to society. Recreation according to Kleynhans (1967) implies recreating, refreshing through diversion, adventure and stimulation; i.e. it is a period of psychological regeneration and development. Recreation is also viewed as leisure time activity - i.e. while not being economically employed. This view tends to regard recreation

as a luxury commodity which will become more in demand as the standard of living rises and leisure time increases.

Kleynhans submits that this economic viewpoint by-passes the fundamental social needs, i.e. not just an additional human want. Public recreation has a social obligation to fulfil. Part of its failure to meet and grasp the requirements of the young group, for example, can be seen in the increased psychological attraction and incidence of drug indulgence, not necessarily addiction. Some of the attraction can be said to lie in the release from modern urban stress condition, and the adventure of a psychological trip. Under conservation we discussed man's influence on the deterioration of the environment. But man is also a part of the eco-system and we hear how the deteriorating environment is corroding man both physically and psychologically.

B. PSYCHOLOGICAL AND SOCIAL HEALTH

(Dr. Henning (1971), a psychiatrist points out that man's needs are both physiological and mental. Man's main physiological requirements are nutritional, elementary, sensual and motor needs. The frustration of sensual or motor needs lead to changes in the individual's mental state, e.g. a child or adult's inability to move repeatedly induces frustration and depression.

Henning emphasises that the central city and transitional zone is noted for its psychological and social aberrations. A high incidence of suicides, mental illnesses and high crime rate are typical of the high population density areas. Further, a British survey has shown that more aggressive children are found in built up flat areas. This is related to the limited sensory stimulation and motor activity of restricted urban life.

In the treatment of mental illness, it is today accepted that recreational activity is prescribed in combination with physical medicines. The large parks and gardens surrounding mental hospitals are an important condition in the patient's recovery.

(Professor Theron (1971) submitted that the dense overcrowding of both animal and human populations has resulted in alarming incidences of abnormal behaviour patterns, and mental and social aberrations amongst humans and animals. Calhoun's experiment (Calhoun, 1962) with wild and domesticated rats under conditions of increasing numbers showed alarming disintegration of acquired and instinctive animal behaviour: female rats would not make their nest, nor care for the young; cannibalism, homosexuality and a number of aberrations became common in the male rats. It is important to note that the quantitative and

especially the qualitative facilities and services were particularly instrumental in accentuating the sociological process. The infrastructure (food hoppers) could be so built as to encourage the individual rat to want to be in groups or crowds. This fostered the development of the behavioural deviations.

Further, the eminent zoologist Morris (1969) submits that the solitary confinement and spatial restrictions contributes towards the abnormal animal behaviour in zoos. Further the city dweller faces similar crises; he is isolated in the lonely crowds, and the overcrowding and spatial restrictions induce claustrophobia to a varying degree in all city dwellers.

Theron submits that the complexity of human behaviour lies in the interdependence of the innumerable variables. An examination of some of the accepted important variables indicates a circular process. The high population densities and overcrowding in small concrete blocks leads directly to:

- (a) disintegration of family structure as the family splits up, seeking their recreation and leisure activities away from the home, and not as a family unit but separately. This diminution of family cohesion leads to
- (b) a weakening and destruction of primary group contact and affection and understanding amongst the family members. At this stage the casual relationships inducing mental illness are quite clear. Professor Theron states : "it is essential for the adjusted personality development that the individual grows up as part of a family unit. The common sociological pattern is a disintegrated family structure".

This increasing population density, combined with the disintegration of the family structure, urban stress and monotony, has led directly to the high incidence of mental pathology, and crime and other social durance, in the central city areas. Further it is essential that provision be made for places of urban retreat; and places of recreation where children are unrestricted in motor activity. Not only is the provision of these facilities vital to the sociological and mental health of society, but it is in accordance with the principles of preventative medicine and reducing the social cost of large scale treatment of sociological and psychological aberrations.

Theron concludes : "it is essential that facilities be provided for release from the urban claustrophobia, stress and concrete blocks in the form of :

- (1) park and visual relief systems : within easy access of particularly the lower income groups for afternoon or daily recreation;

- (2) recreation reserves for weekend recreation in the countryside;
- (3) local ~~Plot~~ parks, although small, are better than nothing."

Today it is recognised that as a co-ordinating body, ~~town~~ ^{town}

h *h* planners must relate and consider both spatial and ^{social} planning together. Not only must there be a quantitative provision of services, but the qualitative and sociological implications of the provision of facilities must also be considered, as in Calhoun's experiment.

C. URBAN LIFE

Urbanisation of the world has occurred at an alarming rate, In the year 1800 no city in the western world had more than a million inhabitants - and 1.7% of the world's population lived in cities of exceeding 1 million inhabitants. The figure for 1970 is about 14% of the total world population. (Davis 1967);

McIntosh (1969). Greater London now occupies about 613 square miles ~~whereas~~ ^{and} New York and its suburbs ~~now cover~~ about 2514 square miles. Isolated in time and space the urban man is only vaguely aware of the accelerating rate and magnetic pull of urbanisation throughout the world.

In McIntosh's opinion, the paradox of urban life is the belief that low density housing means a better life. He states that in Los Angeles (average of 5 houses to an acre) more than one-third of Los Angeles is consumed by transportation facilities and two-thirds of the central area is occupied by parking and transport channels, and so inevitably social and recreative facilities are scattered, too far away or usurped for other uses. In 1945 London accepted the standard of seven acres of park, sportsfield and open space per thousand persons. By 1960 the London County Council provided only $2\frac{1}{2}$ acres per thousand of the population. McIntosh concludes ^{that} if the inhabitants of great cities wish to play sport ~~it~~ ^{they} will of necessity be ^{by means of} indoor facilities. Although city corporations are moving towards providing district gymnasias and indoor sports buildings, overseas, there is little evidence that the demand for facilities has been anywhere saturated.

This process of urbanisation and high population densities in urban areas is already on the move in South Africa. In the 1960 census, well over 80% of the Asian and White population groups resided in urban areas. (Pollock (1970)). If today's European and American ~~problems~~ ^{problems} are to be avoided in South Africa in the future, we will have to have a complete reappraisal of the urbanites recreational needs.

5.2.3 LEISURE AND ECONOMICS

A. LEISURE

McIntosh (1969) shows that in 1850 in the United States men worked a little less than 70 hours a week. By 1950 the figure had fallen to 40 hours a week. But besides the quantitative difference, lives are less dominated by their work, which means greater physical and mental energy for leisure. They form part of the large population movement towards outdoor sports and general recreation. The distribution of working time has permitted greater evening freetime, and announced the advent of a weekend a new social phenomena. A mass exodus from the cities results, as people move into the countryside to enjoy outdoor sports like camping, skiing, etc.

In an address to the South African Native Union, Brockman (1961) pointed out that the rising standards of living with longer holidays have released people to enjoy their new won leisure activity. Improved public transport systems, and free-ways, have placed the countryside within easy access of hundreds of thousands of South Africans. Particular emphasis must be given to the lower income groups in planning for recreation needs, as these are usually the people who have the double fate of living in high population density areas and who usually find the most difficulty moving to the countryside or beaches.

He stated that the existing spatial population concentrations, indicate two patterns :

- (a) The four coastal cities, Durban, East London, Port Elizabeth and Cape Town, ~~Here~~ the seashore, and to a lesser extent inland mountains, are the main recreational area.
- (b) The inland concentrations, the Southern Transvaal complex embracing Pretoria, Johannesburg and the Reef: and the Free State Goldfields and a number of secondary towns." Thus the existing population residential patterns indicate a number of interlinked recreational zones.

B. SOME ECONOMICS OF GAME RESERVES

The general concept of leisure can be interpreted in the specific context of Natal. The following observations with regard to trends in the demand for outdoor nature and game reserves were made by the Natal Parks Board. (McCarthy, 1971B.)

SUPPLY:

Game and nature parks in Natal comprise about 500,000 acres or 2½% of Natal's surface area. The last major acquisition was Midmar Public Resort Nature Reserve.

Further, it should be noted that the preponderance of the main national parks, namely Umfolosi, Hluhluwe, St. Lucia, Mkuzi and Ndumu, lie in Zululand. The nearest of the Zululand reserves is the Umfolozi Game Reserve which is about 170 miles or $3\frac{1}{2}$ hours driving time from Durban. Giants Castle is 150 miles or $3\frac{1}{4}$ hours driving time from Durban. Map 1E Game Reserves shows time and distance from Durban and Johannesburg.

This means that the nearest main nature and game reserves in Natal are ^{just} a day's driving away - from Durban, ^{these} i.e. these reserves would tend to be used by tourists and holidaymakers who would stay for a few days. The significance of Durban is that half to three-quarters of the white population of Natal is at present concentrated within Greater Durban.

DEMAND:

In assessing demand the following table should be consulted from which the following deductions are made:-

TABLE 2 ATTENDANCE FIGURE MARKS

RESERVE	ACREAGE	Total Visitors		Av. %	% Rise	
		1963/4	1966/7	Inc.p.a.	1969/70	p.a.
Umfolozi	62,000	4,000	9,300	± 45%	12,900	± 9%
Hluhluwe	57,000	20,400	30,400	± 12%	36,500	± 5%
Mkuzi		3,000	9,900	± 60%	10,400	± 4%
Ndumu		600	1,700	± 40%	1,900	± 3%
Giants Castle		1,700	6,400	± 70%	10,200	± 15%
Source : Director, Natal Parks Board						

Firstly, in the main game and nature reserves in Natal, a phenomenal rate of increase in visitors per annum was experienced in the years 1963/4 to 1966/7. Except for Hluhluwe, the reserves experienced an increase in visitors exceeding 40% p.a.

Secondly, an ecological physical threshold exists however, which limits the visitors to a reserve if the natural habitat is not to be impaired; the advantages derived from nature are not to be annulled by having crowds of people; and if the peak period visitor pattern is maintained.

In the 1966/7 to 1969/70 periods the Zululand Reserves were rapidly approaching the physical saturation threshold, over all the popular periods, and as such have moderate rates of increase in visitors per annum (i.e. 3-9% p.a.).

In addition, Midmar, which is a new reserve only recently

open to the public, experienced a phenomenal visitor percentage increase per annum, as it is only an hour's drive from Durban, and watersports are the dominant features (with only a restricted nature reserve).

Finally, by consumer standards a large demand for additional recreational facilities exists, especially near the metropolitan areas. If the holiday and tourist industry are taken into consideration, e.g. south and north coasts, it is safe to say a phenomenal demand exists there too.

DYNAMIC EQUILIBRIUM

The Natal Parks Board ~~are also of the opinion~~ ^{hold} that the provision of the social infrastructure is a responsibility of the public sector, and the private sector then competes for the provision of the profitable superstructure. Usually the public sector provides commodities where :

- (a) the price system discriminates against the poor, but the commodity is essential to maintaining minimum standards of living, or
- (b) the large amounts of capital investment needed tends to preclude the private sector, or
- (c) collective wants are not provided by the private sector as the value to the individual is much less than the value of the collective commodity to the Society, - e.g. preservation of wild game heritage.

If a state of equilibrium is to be maintained, extensive surplus demand must be avoided by increments to the areas of land available for public recreation. (Further discussion of general economics recreation and open space may be seen in Clawson, (1966), Crocker (1971), Knees (1970), Lewis (1968), and Litchfield (1969, 1970).)

As with all economic activity it is advantageous to have a budget or expenditure ^{programme} plan. In the case of game/nature reserves a development fund for gradual or annual acquisitions is needed. This fund would ensure that a programme was adopted whereby periodic surplus demands were avoided through regular and timely purchases.

It should also be noted that ~~the~~ Natalians benefit from this reserve infrastructure by utilising the service themselves, and by having the wealth of the province raised by capital inflow and expenditure of the tourists and holidaymakers on local goods and services. This means that economic activity, employment and standards of living are raised. This raises the question of tourism. ^{subject}

C. TOURISM

Tourism is a much neglected asset. In Spain 20 years ago tourism was negligent. Today Spain's income from tourism is R2,000,00,000 - three times South Africa's annual gold production. (Cronje, 1971)

The following statistics on tourism have been extracted from Sullivan (1964 and 1967). In America the recreation industry is worth 40 billion dollars p.a. with 60% of Americans taking annual vacational trips. Of these travelling 86% remain in the States; the balance of 14% are international tourists.

The pattern in South Africa is that the National holiday market is probably worth some R150,000,000. Some 2 million South Africans travel away from home - 90% of which take holidays in South Africa, and more South Africans each year prefer holidaying in the countryside. Over a quarter million people visit South Africa's national parks and game reserves. Over 100,000 people visit the mineral springs and places of public recreation in the Transvaal. South Africa is following the U.S.A. trend to ^{winter} outdoor recreations.

Natal is regarded by the travel trade in South Africa as the major touring region in the African subcontinent. ^{It is Province} Natal now attracts some 500,000 holiday travellers a year, and in its own right has a tourist industry worth R46 million rand per annum. Most of these holiday makers come from the densely populated gold fields and ~~over the border traffic~~ from Central Africa.

In 1967 Durban had some 270,000 visitors who left behind them R31 million in spending money. ^{Money} Money spent and respent throughout the whole economy of the city of Durban.

The Province's potential may be assessed in terms of the recreation resources which supply a marketable want. In order of preference the tourist wants to see : wild life (especially lion); the African way of life; the Indian way of life; and meet the local residents; to appreciate the indigenous flora. On the other hand the holidaymaker's requirements and preferences are primarily towards watersports - marine and fresh water; Game Reserves; caravanning and camping; and the youth favour locations with music, night-life and crowd gatherings.

In this list of recreation wants, of both tourist and holiday-maker, there is a strong preference for outdoor recreation facilities. The tourist primarily wants to see wild life, and the holidaymaker to enjoy the beach and sea, or inland water amenities. The provincial recreation resources are such that

this demand can be satisfied. Sullivan (1967) isolates the outstanding Provincial recreational resources as, "the towering mountains in the Drakensberg, tumbling streams and inland fishing waters, wild life and nature reserves, and best selling feature, a 300 mile stretch of sunswept, subtropical seashore. It is an all-year-round product whose appeal rests in the phrase - Unspoilt and Uncrowded."

In conclusion, the goal formulation or examination of the need for local and regional parks and conservation areas has emphasised and supported the need for these amenities. Although recreation and conservation are often regarded as a drain upon public finance and resources, the discussion showed that these amenities should rather be viewed as recreational resources. Not only do these amenities and resources fulfil a basic social need, but they may also be a tourist asset. Instead of being hostile to one another, conservation, recreation and economics are shown to be complementary facets, in a synoptic approach.

5.3 OPENSPACE ANALYSIS

5.3.1 PHYSICAL FEATURES AND INTRINSIC SUITABILITY

A. INTRODUCTION

The physical survey and analysis of the previous chapter rests upon the determination of the bioclimatic groups, which fall within the Lion's River Sub-Region, according to Phillips (1969).

Moving inland within the Sub-Region on Map 2G, these bioclimatic sub-regions or groups range from number 2, the coastal Hinterland about Pietermaritzburg city; to 3, the Mist Belt above the Pietermaritzburg escarpment; 6, Upland Mixed Scrub in the Merrivale valley; 10, the Riverine Mixed Scrub of the Umgeni Gorge; and finally to group 4, the Highland wooded Savanna. The Highland (Group 4) however, falls outside the Howick-Pietermaritzburg Study Area.

A brief survey of each bioclimatic group will reveal the work performed to the benefit or cost to man by the physical features - when left in an undisturbed condition or when subjected to urban development. In other words, a review of the physical features would reveal the intrinsic suitability or capability of the land for certain land uses (McHarg 1969). McHarg isolates eight indicators of these natural processes. Together with these indicators should be considered culturally and scientifically unique and valuable areas; and areas of outstanding scenic beauty.

McHarg's indicators are modified to form the following criteria for the intrinsic suitability for rural or unbuilt up land use: A, surface water; B, marshes; C, flood-plains; D, aquifers recharge areas; E, aquifers; F, steep slopes exceeding 15 per cent; G, scientifically valuable areas; H, outstanding scenic areas; J, forests and woodlands; and K, flat land.

The first important aspect is that this rating classification serves a dual purpose of indicating suitability of urban and non-urban land use. The criteria A to K indicate a diminishing suitability for conservation and recreation uses, whereas if the criteria are reversed K to A reveal suitability for urban use. Surface water is, thus, the most unsuitable and flat land the most suitable for built up areas. It should be noted that the ratings are not quantitatively precise, but rather show a general trend from A to K or visa versa.

VI OF

Besides selecting between the alternatives of urban and non-urban land use, in the first sieve, a second sieve should be introduced. The alternative between agricultural suitability and conservation - recreation suitability should be ascertained. There is an inherent consideration of some agricultural aspects in the suitability rating with the inclusion of steepland and flat land. The ^{Agricultural} consideration, however, is made explicit and more comprehensive in the second sieve. (McHarg suggests that prime agricultural land should be excluded from urban use, as well as conservation - recreationally valuable land.)

The indicator classification is a synopsis and guide to areas where the processes of nature perform work to the benefit of man. Although many of these characteristics of nature have already been discussed in the previous chapter, the following are some further examples. As with the other elements of the environment, water has a threshold for absorbing waste elements, while still processing and purifying the water quality. Water quantity control is seen in the marshes and sponges - especially at the Umgeni source. The natural plant cover provides protection against the climate, and thus prevents costly soil erosion and consequent siltation of major dams which represent a high capital investment. Surface water when dammed serves as a water storage point, flood control, and recreational resource. Marshes, besides controlling the water supply, are valuable as breeding grounds for wild life and fishes. McHarg points out that certain agricultural and recreational uses are also possible in marshes. He also advocates that plains liable to flooding during the fifty year term should be excluded from intensive built-up urban usage. Aquifers or underground water, maintain the provision of clean water, which is an essential need of the city dweller. Care must also be taken in the siting of septic tanks. In this context, McHarg suggests low residential density and or woodlands as compatible uses.

Steep slopes are an important parameter limiting the amount of arable land. The slopes greater than 15% have been excluded from agricultural classification by Scotney and Ludorf as being inducive to soil erosion (Map 2D). Steep slopes may well be used for forestry and scenic areas. In addition, forests and woodlands are important for reducing soil erosion, flood costs, and air pollution costs. Forests also provide benefit in the form of cool, clean air in the airsheds; timber; wild life

1 - *Scotney and Ludorf's proposal*

and recreation areas.

The most striking economic aspect of these natural processes is that generally the costs and benefits accrue to the community as a whole. They fall within the classification of community or social wants as opposed to the individual want of the single consumer. The market reflects the value of a commodity to the individual buyer only. (The market prices, thus, undervalue the social costs and benefits.)

A physical survey to detect the intrinsic suitability for conservation and recreation land uses, follows in the next section. The survey utilises the concept of ~~Bioclimatic~~ groups to investigate the Howick-Pietermaritzburg Study Area, i.e. the south-east quarter of the Howick Sub-Region, on Map 1F). The survey examines in greater detail the Midmar and Karkloof Falls recreation-conservation areas, isolated in the previous Sub-Regional physical Survey.

B. INTRINSIC SUITABILITY SURVEY BY BIOCLIMATIC GROUPS.

BIOCLIMATIC GROUPS 2 and 3.

2. COAST HINTERLAND: Evergreen Forest, Short Forest, Bush and Wooded Savanna : humid to subhumid.
3. MIST BELT : Evergreen Forest, Short Forest and Wooded Savanna : humid to subhumid.

First Sieve: Intrinsic Suitability for Non-Urban Use.

Bioclimatic group 2 : Coast Hinterland is extensive in the south western surrounds of the Tugela Basin. (Phillips 1969) Pietermaritzburg falls near the edge of this group, and also the edge of the Howick Study Area, see Map 2J.

Physiographically, Pietermaritzburg city is situated in a basin surrounded by beautiful hills. The ~~Central Business~~ District is approximately at the bottom of the basin at an altitude of some 2000 ft. (610m). To the north of the city the land rises steeply out of the basin, towards the Hilton-Pietermaritzburg escarpment. (The escarpment also forms the boundary to bioclimatic group no. 3 Mist belt.) The escarpment gently rolls into hills at Edendale and Bishopstowe to the south-west and east of the city. South of the city the topography gently rises and increases in altitude. The southern suburbs can thus look across the business area at the bottom of the basin, towards the forested escarpment and foothills.

Bioclimatically, the basin formation combined with the wind currents and temperature inversion is creating a smog problem.

The extensive and attractive forests on the slopes north of the city are a major scenic asset.

Physiographically the Mist belt, group 3, coincides with the Natal Midlands and the Hilton ridge, (Map 2C and overlay 2G), and generally occurring above an altitude of 4000 ft. (1219 m). The overlay, 2G, shows a strong correspondence with the Eccca series. In the Pietermaritzburg escarpment this is of particular importance as landslides occur in the escarpment area. The steep hillside, composed of pervious sandstones overlying highly plastic clayey shales, is conducive to landslides. The largest landslide occurred below the World's View radio mast, on the Country Club side. Generally the sandstones of the middle Eccca series form the escarpment.

The escarpment rises some 1000 ft. (305 m) above the city. (Maps 4A, 4B.) The eastern portion of the escarpment separates the countryside into the Umgeni River and Umsindusi River drainage systems to the south. The lower portions of these rivers are sinuous along the plains, where floods often occur in the high rainfall months, between December and March.

Bioclimatically the escarpment also affects the micro-climatic pattern by inducing thunderstorms at the summit, where the average annual rainfall is 40 inches (1020 mm) as opposed to 30 inches (780 mm) in the city below. Temperature inversion occurs at night with the cold air drawing down the valleys into the city where, on filling the hollow, air stratification follows. This means that while cool clean air comes down the wooded valleys, the cold valley temperature and air movements trap the atmospheric pollutions. Clearly not only is the siting of industries and control of effluent most important, but the preservation of the air sheds must receive attention.

In terms of the Howick Study Area, group 3 along the Hilton ridge and Pietermaritzburg escarpment forms a major dividing line between the coast and the interior. The Howick benchland and midlands form the second of the steps leading into the interior. An overlay of topography and bioclimatic sub-regions (Maps 2A and 2G) show the Mist belt following the mid altitudes of 400 to 5000 ft. (1219-1524 m). This map combination also shows the Hilton ridge and Zwartberg escarpment as rising above the Merrivale-Midmar valley. The land use Map 2H reveals that most of the northern, as well as the southern aspects of the Hilton ridge are densely covered by wattle plantations. Map 4B also shows the Cedara Forest Reserve, above the agricultural College,

Pietermaritzburg city and Midmar Lake. This supports Phillips (1969) who states that the Mist belt, group 3, is essentially ecologically forest country and the finest wattle producing conditions in the country. Most of the plantations are owned by the private sector.

The indigenous forests or Podocarpus forests, Map 2E, occur predominantly within the Mist belt, group 3. The major indigenous forest resource occurs further inland above the Karkloof escarpment. Smaller forest clusters are found lower down the Karkloof, and also on the southerly slopes parallel to the Lions River. Although he refers to these indigenous forests as exploited shells, Phillips (1969) states that in general they are of aesthetic and scientific interest as relics of the original ecosystem and serve a useful purpose in the conservation of water. He also notes that the typical larger herbivores would have included bushbuck, grey duiker, wild pig, buffalo and elephant.

From Scotney's (1970) land use capability classification, he proposed agricultural and major recreation uses within the Lions River Soil Conservation District. The agricultural classification and suggested nature conservation areas are shown on Map 2J. Of the seven major existing and proposed wildlife and recreation areas, the largest conservation area is the Upper Karkloof denoted by area 6A. The lower Karkloof area, 6B, above the Umgeni Gorge; Maritzdaal Forest Reserve area 6E; and Fort Nottingham Forest Reserve area 6F; also fall within the Mist belt group. It should also be noted that these recreation areas are essentially defined by the presence of the Podocarpus forest, usually on moist south facing steep slopes. Another major recreational area is the Nromandie Nature Reserve, 6B, although it falls just outside the Mistbelt, group 4.

The lower Karkloof nature area, which is also adjacent to the Umgeni Gorge is the only area to fall within the Howick-Pietermaritzburg Study Area. Besides possessing scenic falls, the Karkloof area contains the scientifically valuable relics of Podocarpus forest climax.

The second area intrinsically suitable to conservation and recreation lying within the Howick Study Area, is the Pietermaritzburg escarpment. Not only are the steep slopes, forest and plantation cover good indicators, but the creation of an open space or visual relief system would be advantageous in providing an area of green woodlands visible to most of the city;

prevent building near a landslide prone area; and protect the benefits derived from woods in the airsheds. The slopes approaching and exceeding 1:5 (or 20%) at the base of the escarpment, together with the escarpment's very steep slopes are thus considered suitable for conservation.

SECOND SIEVE : AGRICULTURAL SUITABILITY

The second sieve ~~or step is~~ ^{is to} consider the alternatives of agricultural land use versus conservation-recreation land use. This is a secondary sieve as it selects between two non-built-up land uses.

Little difficulty is experienced in considering the Pietermaritzburg escarpment proposals shown on Map 4B. The steep slopes exceed 15% and thus automatically exclude agriculture. The physical features are, however, suitable to forestry, and much of the slopes have Podocarpus forest in steeper areas and wattle plantations on the shallower slopes, especially along the base of the escarpment. The concept of plurality or complementary land usage is discussed in McHarg (1969). He points out that rather than being mutually exclusive, most land mosaics are intrinsically suitable to more than one use. (The conflicting land use is the encroachment of residential development and to the agriculturally suitable and recreation and conservation areas.

The Karkloof Falls area (proposed nature area 6B on Map 2J) is more difficult to assess, as the area lies in Scotney's 1st class agricultural capability grouping. In general the Podocarpus forests relics are usually found on the steep slopes which have escaped the ravages of the plough. These forests would require a detailed local survey to assess their boundaries and the local agricultural potential. In general, though, the forests are highly suitable for conservation.

BIOCLIMATIC GROUP 6

Upland Mixed Scrub and Wooded Savanna; moister faciation (subhumid to mild subarid).

FIRST SIEVE: DESCRIPTION AND SUITABILITY FOR NON URBAN USE

Physiographically the Upland Savanna group 6 follows the upland on the Howick benchland between altitudes of 3000-4500 ft. (914-1372m); vide Maps 2A, 2C, 2G. The upland, group 6, incorporates the Midmar peneplain, following the Howick benchland around through the Borough of Howick to the undulations on the northern portion of Umgeni Gorge and valley.

The Umgeni River forms a link between the two Bioclimatic groups and flows through group 6, (upland savanna) to unite it to group 10 (subarid riverine scrub), where the Umgeni crashes down the scenic and historic Howick Falls. The river continues to the confluence with the Karkloof River and the wide flood plain lower down. Both groups 6 and 10 occur on Ecca sediments of shales and sandstones, with dolomite sills or dykes occurring. No information on the underground water in relation to the geology was, however, available.

The surface water of the Umgeni has been allocated for the Pietermaritzburg-Durban requirements. The shape of the Merrivale-Midmar valley as a prime location for water storage and management led to the creation of Lake Midmar which is the dominating socio-physical feature of the Upland - savanna, group 6. The gentle cultivated and grassed slopes of the valley result in the dam being visible from the surrounding areas (vide Maps 2H and 3B. As Midmar is a major public resort owned by the Parks Board, (see Map 4B) the aesthetic considerations of the surrounding landscape should be considered carefully.

The natural process of water purification, *of the Umgeni river* is seen in the cleansing of the ~~faecal Umgeni water~~ pollution below Howick before reaching the confluence of the Karkloof and Umgeni. Further, the preservation of the catchment from undesirable land uses is necessary. Catchment conservation, and management either in the upper reaches of the Umgeni, or about the dams, may relate to both urban and non-urban use. Overgrazing and consequent soil erosion and siltation are examples of *PA to NRC* agricultural abuse. Urban use surrounding the lake will markedly affect the run off water into the lake; sewage pits can seep or pollute ground water; and industrial and domestic effluent can well pollute the lake asset beyond its threshold of absorption and recovery. The synoptic view of the water resources and their use should be entertained especially when considering the land use in the neighbouring townships or agriculture.

Related to recreation are aesthetic, historic, scientific and culturally valuable *natural* criteria. (Phillips 1969, 1970C). The only noted historical monument in the Study Area is the Howick Falls. From the point of view of landscaping and maintaining the aesthetic appeal of the recreation asset, consideration must be given to the Bantu Township Montrose, and portion of the Indian township, Howick West, which intrude over the watershed into the Midmar valley (see Map HB). In

the conjunction with urban development is the factor of disease infecting the water supplies. Bilharzia tends to occur below altitudes of 4000 ft. (1219 m). Phillips (1969) also notes that the intermittent cool spells in summer and cold periods in winter for Upland Scrub and Savanna, group 6, where in general the Bilharzia is less virulent, may be expected. In relation to Midmar specifically Jackson (1970) expressed concern regarding this potential public health hazard. (This point is discussed in detail under aquatic pollution in the industrial location analysis.) Great care should be taken in the management and planning of water resources, as water is a most efficient form of transmission of many diseases with disastrous results (Phillips, 1966).

In conclusion the Midmar valley of the Upland, group 6, possesses prime recreational and conservation qualities. Scotney (1970) also gave Lake Midmar the highest recreation capability rating in the Sub-Region. Besides providing boating and yachting facilities, the lake borders the marsh area along the Lions River (Map 2H), which have potential for wild life, although not included within the public Midmar Nature Reserve Area (Map 4B). The lake also requires conservation as a major water impoundment for the urban areas of Pietermaritzburg and Durban. The likelihood of pollution or disease would be minimised by conserving the valley, while also enhancing the aesthetic value of the scenic locale. Phillips (1969, 1970) suggests that the previous animal associates of the Upland, Group 6, were probably hartebeeste, eland, buffalo and elephant.

SECOND SIEVE : AGRICULTURAL SUITABILITY

Scotney (1970) as outlined in the previous chapter, (section 4.5) considered the Merrivale-Midmar Valley below the lake (Eco-area 2A, 2B on Map 2J) to be of moderate or 3rd rate potential. With the main limitations of moisture deficiency and physical limitations to the soil, he considered the ecological area to be suitable for semi-intensive agricultural uses. Here the gentle slope of the valley and the proximity of markets indicated a moderate degree of intensification. The main lines suggested were intensive fresh milk on summer pasture and fodder crops. The rated soils, on Map 2D, show patches of the rare eminently rated soils for agriculture. The Upland, group 4, within the Merrivale-Midmar valley has a high concentration of moderate soils.

Above the lake in Eco-area 2A, Scotney considered this area to be of 2nd rate or high potential for intensive arable

agriculture. ²² Limitations are mainly ~~due to~~ a moisture deficiency, inherent low fertility in the soil and topographical features - hilly terrain. He recommends this area for very intensive fresh milk on pasture with cash crops and horticulture as main lines.

The agricultural suitability, thus, is compatible ~~to~~ ^{with} conservation and recreation. The area is of moderate to high potential (3rd to 2nd rate) and can be sufficiently intensively used to justify the continuance of agricultural use, especially to the south east and to the north.

~~The~~ Agriculture affords the protection of the water impoundment, while not preventing the inclusion of marginal and neighbouring land into the Midmar Recreation and Nature Reserve, as shown on Map 7B.

BIOCLIMATIC GROUP 10

SUBARID RIVERINE AND LOWLAND, MIXED SCRUB AND WOODED SAVANNA

Physiographically the Umgeni River Gorge is a continuation from Lake Midmar, in the Uplands. Below the Howick Falls the river has incised a deep gorge which opens out into the flood plain lower down at Albert Falls. A similar physiographic pattern is followed by the Karkloof River below the Karkloof Falls, joining the Umgeni just above the estimated high water level of the proposed Albert Falls Dam (see Map 4B).

The Umgeni Karkloof Gorge and valley is composed predominantly of horizontally lying sedimentary rocks of the Ecca beds of the Karroo system. These beds include sandstone and shales. This pattern is interrupted by the common occurrence of dolomite sills which intrude into the Ecca beds. The Howick Falls, some 365 feet, and the only proclaimed Historical Monument in the Sub-Region, is formed by unusually thick example of all of these igneous bodies. The Falls provide one of the most dramatic exposures of dolomite in the Province. Due to the incised nature of the countryside, excellent exposures of all the rock types present are available for study.

Probably of greater scientific value are the fossil leaf impressions which occur on a tributary to the Umgeni River. The leaf impressions (between 255 and 265 million years old) are representative of a group of plants known as the Glossopteridae. These plants have been extinct for the past 200 million years. Sites of this nature are rare and of great scientific value. Only ten such sites have been recorded in Natal to date (Anderson 1970, in McCarthy, 1970B).

The grass cover of the Umgeni valley has been placed into three basic types by Moll (1970 in McCarthy 1970A). The Aristida junciformis grassland lies on the tops of the ridges and the first slopes. This is followed by the mixed Tall Grassland with species of Cymbopogon and Hyparrhenia on the steep southern slopes. In the lower valley the Eragrostis/Sporobolus grassland forms an under storey to the woody vegetation. Four types of woody vegetation are also noted : cliff communities, Kloof forest; Savanna and woodland communities and finally Scrub and Thicket communities, with Acacia Karroo and Acacia nilotica. Moll notes that the Kloof forest varies widely, with differences in soil, moisture and protection against fires, now examples occurring especially below Karkloof Falls. With regard to the uniqueness of the flora he states, "the sheer diversity of vegetation represented in a relatively small area is an important factor. Rare and interesting plants at present are Encephalartos natalensis (the Natal cycad), Protea roupelliae (a type of Sugar Bush), various aloes, and Erythrina latissima (the large-leaved Kaffir Boom).

Hydrologically the Albert Falls Dam, at a point below Midmar Lake, forms an integrated portion of the Umgeni River System (as discussed in more detail in section 4.3.3). Like Midmar, higher up, the water impoundment at Albert Falls is dependent upon the conservation of the catchment area; prevention of erosion or pollution from runoff, ^{and} or sewage. The domestic sewage from the adjacent townships, notably Howick, is an important factor in maintaining the water purity. The N.I.W.R. (1967) report showed a drop in the Umgeni water purity from Class III to Class IV due to the sewage import below Howick. The Albert Falls Dam is obviously also dependent on the preservation of the water quality in Midmar Dam, the overflow of which leads directly to the Albert Falls Dam lower down (Map 4B). Residential development should be carefully controlled or excluded from both Midmar and Umgeni Valleys.

Recreationally the Umgeni-Karkloof has a very high or first-class potential, possibly exceeding even Midmar Lake, which is the premier water resort in the Province. The Albert Falls Lake and Midmar Lake form a major recreation axis which passes through the Borough of Howick. Midmar Lake is a proclaimed public recreation resort under the administration of the Natal Parks Board. Below the Falls a private game reserve is in the process of being established with the aid of the Parks Board (Map 4B).

The continuation of this recreational axis down the Umgeni River to join the Albert Falls Lake would provide a major recreation asset for the Province, as supported by the preceding general motivation (Section 5.2).

In this regard the Parks Board stated (McCarthy 1970A), "in representing valley extensions of the Dry Thornveld zone, the river valleys are eminently suitable for wild life conservation. The Howick and Karkloof Falls and attendant gorges possess scenic values of a very high standard. Preliminary investigations would indicate excellent habitat for large lowveld mammal species, and this observation is supported by the fact that introductions to the Game Ranch Area below the Howick Falls in 1969, have proved entirely successful."

In conclusion it may be said that the development of a major recreational axis between Midmar and Albert Falls Lakes with the inclusion of the Umgeni and Karkloof Gorges and valley as a game reserve would afford major benefits to society. This recreational axis could be linked to the visual relief system of the Pietermaritzburg escarpment. This proposal, recreation-conservation, as outlined on Map 4B, would contain the benefit of preserving rare and valuable sites of scientific value for posterity. These sites include the vegetation communities, and Karkloof Falls Podocarpus Forest relics; the dolorite sill above the ~~historic~~ Howick Falls; palaeontological specimens. The establishment of a major game and nature asset would ensure the conservation of the catchment area, and thus the prevention of the pollution and siltation costs in the water impoundment, at Albert Falls. The double recreational asset of aquatic resources and terrestrial nature and game reserves would be provided. The integration of the Midmar and Albert Falls proposals, with each other, and with the visual relief system along the Pietermaritzburg escarpment would create a major provincial recreational asset.

SECOND SIEVE : AGRICULTURAL SUITABILITY

Scotney (1970) gave the top portion of the Umgeni Gorge the lowest rating - class 5, or very low agricultural potential for intensive use. This land is suitable only for extensive systems of farming based on the natural veld. The major agricultural limitations are the severe moisture deficiency and the very high erosion hazard combined with the topography. This is supported by the Natal Parks Board (in McCarthy 1970A) who commented on the low agricultural potential and state that "the steepness of the valley slopes, the presence of unstable surfaces in many parts

and the nature of the vegetation upon these soils, place even greater emphasis on the desirability of a land use based upon conservation of the natural factors."

Clearly the recreational proposals for the Umgeni-Karkloof River Gorges and valley are in accordance with the agricultural capability or potential for the area. Not only do the proposals not suggest the removal of any but the lowest potential land, but the conservation-recreation proposals would manage and conserve the physical features better than agriculture would. Greater benefits would thus accrue to society from the use of the amenities, and the avoidance or minimisation of specific social costs such as erosion, siltation and pollution.

C. CONCLUSION

The natural features revealed an intrinsic suitability to a woodland green open space system along and at the base of the Pietermaritzburg escarpment. The system runs through Winterskloof on the west, behind the city, curving out to Otto's Bluff and returning on the back of the Hilton ridge, concluding behind Midmar Lake. (vide Map 4B.)

The usual relief system, as shown in Map 4B, contains three major elements ; relief too steep to be built on or serviced economically; woodland, approved agricultural use or natural scenery providing relief from urban monotony and prime agricultural areas reserved for agriculture. The main benefits from the system would be : the provision of a scenic backdrop to the city; a green entrance to the city, integrating with local urban open space (Map 2H) at the Country Club Golf course, and the Queen Elizabeth Nature Reserve. Finally, when continued to Otto's Bluff and along the Zwartkop Escarpment (Map 4B), the visual relief system supports and merges with the major recreation axis.

The recreation axis joining the Midmar and Albert Falls Lakes, follows the course of the Umgeni. The Umgeni-Karkloof valley nature reserves would ensure the protection of the water resources while providing a major recreation asset. The proposals make provision for the preservation of sites of scientific and cultural value, wilderness and recreation areas close to Pietermaritzburg, and within striking distance of Durban.

5.3.2. SOCIO-ECONOMIC FEATURES

Having considered the physical structure or environment, attention was directed towards the socio-economic features.

The survey does not purport to be a plan, i.e. it does not measure future demand or examine the means for obtaining social goals. A brief survey of the human features has, nevertheless, been undertaken so as to provide a feasibility modification to the intrinsic suitabilities detected in the physical survey.

A. RESIDENTIAL PATTERN

The Pietermaritzburg residential distribution is shown in Map 4A. The White inhabitants of the City can only reside along the north-west-south-east axis. Bantu living at Edendale and Swartkop location are a barrier to expansion westwards and Indian, Coloured and industrial areas constrict expansion eastwards.

In general the lower-income group has spread in a southerly direction towards Mkondeni, and in accordance with Homer Hayt's locational theory, the higher-income group has favoured the higher ground. This economic and social differentiation is basic to the whole residential structure (Murphy, 1966).

On the micro-analysis land available within the City for the higher-income group will be developed in the medium-term. Sales of land at Athlone and Montrose have been rapid and the price high. This implies that pressure on the peri-urban areas to the north will in future increase.

The steep escarpment which surrounds Pietermaritzburg forms a topographic and cadastral boundary to the Borough of Pietermaritzburg (Map 4A). Both Sweetwaters and Winterskloof are located along this escarpment woodland zone. *Just (on main European Farm)*

To the north, Hilton straddles the heights, in the mist-belt. The land then falls into the Cedara-Merrivale valley, with a concomitant change of climate; a lower rainfall - especially to the south of the National Road, near the Boston Road, where the area falls into a rain shadow. Cedara Agricultural College forms a constraint to other development (Map 4F). There is a small ridge separating Cedara and Midmar Lake. Mpophomeni Bantu township is separated by a north-westerly continuation of the Cedara Escarpment. The Midmar valley extends to the south-west.

To the north of the National Road, undulating grassland and wattle plantations end right at the edge of the escarpment to the Umgeni-Karkloof Valley; Hilton College forms another restraint. Howick and Merrivale are along the edge of the Umgeni Gorge which forms a constraint to their expansion in this direction and St. Joseph's Scholasticate could also be a further constraint in residential expansion.

To the north-east of Howick the terrain becomes more hilly, but not unsuitable for residential use. In the north-east, above the Karkloof Gorge, the topography takes the form of gentle downs. To the north-west of Howick the area takes the topography of the rolling Natal Midlands.

To the north of Midmar Lake, is the fertile Dargle Valley, which is already heavily subdivided into 50 acre lots. To the north-west rise the cold mountains of the Intlezani.

B. INTEGRATION OF TRANSPORT SYSTEM AND INFRASTRUCTURE

The Howick Study Area is bisected by the rapid transit National Road. Estimated travelling time to Pietermaritzburg from Merrivale, is 15-20 minutes, and from Lions River 25-30 minutes. The road system provides easy access to the Drakensberg, via the Boston Road, Durban, or to the local villages along the Old Main Road. As Pietermaritzburg is approached, the secondary roads through Hilton and Winterskloof are all tarred. The Sub-Region has therefore a comprehensive network of farm roads, secondary main roads, and the primary National Road System.

In general the provision of water and disposal of sewage appear to be the serious service difficulties.

The Department of Water Affairs delivers raw water at 6c per 1,000 gallons to Pietermaritzburg Municipality at Ferncliffe Purification works. The municipality built Ferncliffe at an approximate cost of R500,000 and can economically purify 6 millions gallons per day. Ferncliffe was built by the Council, in order to supply water to the City's residents in future and also to be able to supply water to Hilton at 35c per 1,000 gallons who in turn sell it to Winterskloof at 50c per 1,000 gallons.

All the small local authorities in the area are experiencing difficulty with the provision of water and other services. This is basically because their funds are rather limited. Sweetwaters, Winterskloof and Hilton could form a single source drawing off Ferncliffe if the Pietermaritzburg Council were agreeable. (No difficulties are foreseen.) Merrivale is considering joining Howick water reticulation which is supplied direct from the Umgeni River (200,000 gallons per day) and Midmar water supply.

In the long-term water distribution does not appear to present any major difficulties, while over the short-term any strengthening of local authorities by amalgamation should improve the provision of water services.

Attention is drawn to the comments of the Town Clerk of Pietermaritzburg that no subdivision under 40,000 sq. ft. (3,720 sq. metres) should be permitted before comprehensive percolation tests for sewage have been conducted.

C. DEMAND FOR SMALL ESTATES

The general trends in agricultural subdivision to 50 acre lots around Pietermaritzburg, is shown in Map 4D. It should be noted that the ring continues off the map to Bishopstowe in the south. Constraints to subdivision or expansion have also been indicated.

The conclusion reached from an investigation into the demand for lots between 1 and 50 acres was, that if the intermediate lot sizes were not available, the higher-income group would move further out of town, and purchase agricultural subdivisions, as the absolute price for smallholdings and one acre plots is comparable - Map 4D. Such an attitude has rendered Dargle Valley productively a poor agricultural area, although agro-ecologically it is a prime agricultural area.

Although subdivisions have been accelerated by an immediate fear of further control, this should not materially alter the picture because the subdivisions shown on Map 4D were over the last 3 years, and many of the panic applications are still in the pipeline awaiting approval, and therefore are not all recorded on Map 4D.

A demand for large plots was shown at both Winterskloof and Hilton. In 1965/66 a survey of Hilton was undertaken in order to establish need and desirability for residential development. The survey showed that although about 60% of the erven were undeveloped, there was a definite preference for plots of more than 2 acres. With the shortage of available land and general rise in prices, more people have begun to subdivide.

Thus although percentage development is quite rightly taken as an indication of need for further land subdivision, this indicator is less sensitive in higher income areas.

D. BRIEF SURVEY OF LOCAL AREAS.

HILTON

Hilton is the most prestigious residential area. Winterskloof and Sweetwaters come a close second. These areas, until recently, were able to maintain a rural atmosphere, with the inhabitants having smallholdings, which were used for agriculture or domestic abode. With the considerable rise in property values over the

last few years economic pressure is being exerted on the owners of the smallholdings.

A number of individuals or farming companies have considered it expedient to subdivide their land, usually into acre or half-acre lots. This has placed pressure on the adjacent smallholdings, for three reasons.

Firstly, the owner of the smallholding becomes aware of the value of his land for subdivision and development.

Secondly, the more subdivisions there are, the greater the strain on the local infrastructure. As this is improved, and more numerous services are provided, a corresponding increase in rates follows.

Thirdly, either the destruction of the rural character of the area, or the increase in rating, will cause more smallholders to sell.

Like the Negro invasion and White ^{cession} ~~succession~~ in an American suburb, a similar process of dynamic transformation is present at these peri-urban areas. (Murphy, 1966)

Ultimately the question of Urban Development pattern must be considered. The alternative lies between concentrated large areas of spatially and socially homogenous residential development vrs differential, or dispersed residential areas. In principle, monotonous concentrations are undesirable, but in practice, such factors as physical structure, population distribution, integration of transport system and infrastructure, etc., must be considered. By 1990 the present 45,000 White population of metropolitan Pietermaritzburg will have more than doubled and there will be a scarcity of land in the City for the majority of the high-income group.

According to the Pietermaritzburg Traffic Consultants, the White population of Hilton, Winterskloof and Sweetwaters, will have more than trebled from 2,180 persons at 1968 to 6,830 by 1990.

WINTERSKLOOF AND SWEETWATERS

On the 18th April, 1968, 167 out of an estimated total White population of 270 persons, signed a petition to the effect that they were conscious of their environment, and decidedly wished to preserve its rural character. An absolute minimum of 2 acres was desired for all subdivisions. This clearly demonstrates the demand for small estates, and the desire to retain them once obtained.

Firstly, no motive apart from profit can be ascertained why a number of individuals and corporate bodies should start the

process of destroying or changing the natural character of the two areas. Further, such a process of change would be against the wishes of the inhabitants. In addition, the average lot size (which exceeds 5 acres in Winterskloof) is an economic indication of the present residents' demand. Thirdly, the two local authority areas are adjacent to Swartkop Bantu Reserve and White residential expansion is, therefore, limited. The topography, because of steep slopes in the valley, is more suitable for large plots. Finally, these two areas fall within the greenbelt, as defined by topography and altitude, and in order to preserve this, development should be controlled and restricted in the area. It is also desirable from the planning point of view to maintain heterogeneous residential nuclei, in order to avoid monotonous and homogeneous spatial and social residential patterns.

It is thus suggested that future subdivision on the eastern slopes of Winterskloof and Sweetwaters be not less than 2 hectares (five acres).

It is also suggested that consideration be given to the amalgamation of Sweetwaters and Winterskloof local authority areas. Amalgamation would have the benefit that the provision of public services, especially water and roads, would be facilitated, and control over the two areas would be strengthened. Developers would then be in a weaker position as regards the Local Health Committees (therefore reducing the danger of excessive traffic on the narrow roads). Socially, aesthetically and topographically, the two areas form a compatible unit.

It is suggested that consideration be given to extending the boundary of Winterskloof to incorporate a buffer strip with 5-acre subdivisions between Winterskloof and Hilton Health Committee Areas. This is because the character of the two areas is different. Hilton desires population concentration and Winterskloof does not. The character of the Winterskloof area would need to be protected in the event of amalgamation with Hilton.

OTHER LOCAL AUTHORITIES

Cedara College dominates the few cottages and lower income housing found at Cedara. Merrivale is rapidly changing from a number of smallholdings to residential plots which range upwards from 20,000 sq. ft. The average plot size is 1 acre. The inhabitants are not of the higher-income group and a number of the smallholdings have a scruffy appearance. The presence of

of Cedara College on soils eminently suitable for agriculture would suggest that the possibility of creating high density residential areas adjacent to Cedara, should be investigated. This would permit large numbers of people to enjoy the agricultural scenery, and the illusion of a rural environment while maintaining a concentrated use of land.

To the north lies the town of Howick which has an economically-mixed White population. There is a large number of lower-income semi-skilled factory workers, together with a managerial stratum and group who commute to Pietemaritzburg. Howick, like all the other rural villages to the north, depends on the local wealthy farmers to support the commercial sector, and the agricultural affairs in the villages.

The band of agricultural subdivisions around Howick, especially in the Dargle Valley (Map 4D) and near Lidgetton, form the small estate homes of the high-income and retired group. The recreational proposals should stimulate the development of the town as a resort.

To the west of Howick lies Howick-West which has recently been proclaimed an Indian Area, and which, together with Mpophomeni, represents the non-White group or lower-income group. Both Townships are adjacent to Midmar Lake. (See Map 4B) Although Howick-West is bisected by both the National Road and railway line, and hemmed in by the Umgeni River and Midmar Resort, any expansion of Howick West into the Midmar catchment area or across the Boston Road towards Hilton, would be undesirable. Expansion towards Midmar is likely to create pollution difficulties, and movement towards Hilton, create group areas problems.

Growth trends shown in the population growth rate of 4% per annum compound, indicate a consistent migration into the area. Average land prices are high: R4000 per acre as compared R750 per acre in 1963. Notwithstanding, values are lower than at Raisethorpe. The area is approximately 450 acres in extent with a density of 2.5 persons per acre. It would thus appear reasonable to suggest the necessary expansion of Howick-West, in the possible direction towards Howick.

The Bantu township of Mpophomeni is situated within the catchment area to the main water impoundment. The dangers resulting from any overpopulation, or exacerbation of the present position are dealt with under Industrial Desirability Analysis. Furthermore, the function of Mpophomeni has been stated as being a residential area for Howick's Bantu labour. It is for this reason that any

labour attractions should not enter the study area. The population estimates which are not reliable indicate that Mpophomeni may in the middle-term exceed its capacity, in which case is strongly advised against. Any expansion of Mpophomeni township or the Swartkop Native Reserve within the Midmar Area, or towards Cedara, would be most undesirable, being likely to create pollution and group areas difficulties.

E. CONCLUSION

The brief survey of the prominent socio-economic features revealed a corresponding support ^{to} the green open space suitabilities and proposals. A strong demand exists within the high income areas to the north of Pietermaritzburg City. The steep terrain of the Pietermaritzburg escarpment, and the visual relief system sweep through Winterskloof and Sweetwaters. These two local authorities possess rival character with small holdings predominating. This coincidence of physical and socio-economic features suggested the preservation of Winterskloof and Sweetwaters as part of the visual relief system, with subdivisions restricted to 5 acres (2 hectare). Further, the similarity of character, together with the benefits accruing from the provision of services suggested the amalgamation of Winterskloof and Sweetwaters.

The physical constraints to residential development are considerable. On the west lies the Zwartkop escarpment while on the east are the steep walls of the Umgeni Gorge. The Gorge also forms part of the Nature and Game Reserve proposals for the recreation axis. Between the Gorge and the Zwartkop escarpment is Cedara Agricultural College, which is sited on A grade eminently suitable soils for agriculture. Below the ^{plantation} escarpment is the Cedara Forest Reserve. The Cedara forests, and lands are likely to strongly resist residential subdivision. The possibility of developing high density residential areas with rural surroundings adjacent to this agricultural nucleus should be investigated.

The expansion of the residential areas to intrude into the recreation axis would create landscaping and pollution problems. In addition, the margins of the game reserves should be maintained as transitional zones to the biotic features. The margins of the Umgeni Nature Reserve and Midmar valley should be reserved for agriculture. This implies that Merrivale, which is on the margin to the Umgeni Gorge, should retain its nature of small-holdings. The extension of the Indian Township, Howick West, over the Midmar watershed, or into the direction of the advancing high-income suburbs would be undesirable. The population increase and land values on the other hand are high, thus indicating the need for residential extension, preferably towards the Boston Road. The problem is that there is no hinterland

man for

for expansion for Howick West. The Bantu Township of Mpophomeni, located on the shores of Lake Midmar, is similarly ill-sited. The best suggestion under the circumstances is to restrict the development of ~~this township~~. Alternative sites for additional Bantu townships should be examined, with the proviso that the Swartkop location should not extend across the Swartkop escarpment into the advancing high-income residential sector.

5.4 CONCLUSIONS AND RECOMMENDATIONS

A. PROBLEMS ARISING

The first part was the goal formulation or general motivation. A broad view was taken in regard to the question of providing local and regional open space, i.e. game and nature reserves, local parks and visual-relief systems which utilised the intrinsic suitability of the terrain for recreation or conservation purposes. The goal formulation necessitated a consideration of nature conservation, and natural resource management. Psychological factors and aspects of social pathology demonstrated the physical need for recreation areas. Economic considerations arising from higher per capita incomes and greater leisure time have raised the demand for recreation and tourist resorts.

The second part, the consideration of alternative land uses, was a physical survey for land intrinsically suitable to open space, within the Howick-Pietermaritzburg Study Area. This survey in accordance with the approach advocated by Phillips (1969) and McHarg (1969) considered physical features and socio-economic factors. The survey of physical features required a knowledge in the fields of physical geography especially in order to correlate and appreciate the physiographic and bioclimatic characteristics. Phillips (1969) ^{the} Bioclimatic groups were utilised in the ordering of these physical features. An understanding of the process which nature performs to the cost and to the benefit of man facilitated the detection of areas physically and intrinsically suitable to conservation and recreation land uses. Land suitable for unbuilt-up use was also considered in terms of agricultural potential. The socio-economic survey considered the cultural superstructure which occurs upon the physical structure, and within the physical environment. The residential pattern was considered in terms of property economics, physical constraints and social wants. The socio-economic survey supported and reinforced the conclusion of the physical survey.

B. CONCLUSION

The physical survey detected two major open space areas. The woodlands or visual-relief system followed the steep slopes of the Pietermaritzburg escarpment as shown on Map 4B. The system stretched behind the city extending from Winterskloof in the west through to Otto's Bluff in the East. From here, the system followed the northern aspect of the Umgeni Valley and

gorge. From Winterskloof the visual relief system extended along the Zwartkop escarpment, and thus overlooks the Cedara Flats and Midmar Valley. The visual relief system is desirable in that residential expansion is ~~protected from~~ ^{kept away from} the dangerous landslide zones; the steep slopes suitable only for forestry are extended to incorporate slopes exceeding 20%; the landscaping and aesthetic features of the city are enhanced, while providing a public open space amenity.

The visual relief system was integrated with the major recreation axis which extended from Lake Midmar, into the Umgeni Gorge and valley (also on Map 4B). The upper reaches of the Gorge near the ~~historic~~ Howick Falls have already been developed as a private game reserve. The Karkloof gorge and the Umgeni flood plain at Albert Falls are eminently suitable for conservation and recreation, in that protection to scientific and culturally valuable sites is afforded; preservation of natural areas or witness areas is maintained; conservation of the Umgeni watershed above Albert Falls dam is ensured; and, finally, a major recreation amenity of two lake resorts with adjacent game and nature reserves is created within easy reach of the two cities in the Province.

The socio-economic survey revealed a dependence on the physical features. The local authority of Sweetwaters and Winterskloof which lie within the visual relief system would benefit through amalgamation and consequent economies of scale. The demand for small rural estates, together with the local residents' wishes and the physical features indicate that subdivisions should exceed 2 hectare (5 acres) in Winterskloof and Sweetwaters.

Further, the two non-white Indian and Bantu townships at Howick West and Mpophomeni respectively, are likely to extend further into the Midmar catchment area, unless restricted. Besides the obvious deterioration to the landscape surrounding the nature reserve and lake recreation amenity, such built-up intrusions increase the danger of pollution and health hazards. Consequently, Howick West, Mpophomeni, together with Merrivale and Howick (along the Umgeni valley lip) should take cognisance of these recreation and conservation areas surrounding the major provincial water impoundments. Agricultural land use, under the control or supervision of the Department of Agriculture and Technical Services, or conservation use is preferable in the

Midmar and Umgeni valleys, if the lakes are to be protected and enhanced. Further, greater coordination of recreation and water resource planning could ensure the provision at low prices of large recreation areas, surrounding the major dams.

C. CONTRIBUTION AND LIMITATIONS

The open-space study detected and formed proposals for a major recreation axis integrated with the urban visual relief system, along the Pietermaritzburg escarpment. Although Scotney (1970) considered the Umgeni gorge for recreation use, it was only the upper portion already in use as a private game reserve. The concept of linking the two major lakes by means of a conservation-recreation axis was novel. So, too, was the definition of the visual-relief system which was integrated with the recreational proposals, at Otto's Bluff, and again along the Zwartkop range above Midmar. The conservation-recreation proposals have been accepted in principle and incorporated into the planning for the Albert Falls Lake. The residential proposals regarding Winterskloof have been accepted in principle and already applied in practice, with regard to applications for subdivision.

Although the method employed in the field was conducted without the prior benefit of Phillips (1969) and McHarg (1969), these works have been extensively used in the formulation and presentation of the research results in this work. In this sense this ^{assessment} conservation-recreation is also a test for the ecological approach, in order to interrelate the physical characteristics, detect intrinsic land uses, and correlate with socio-economic, aesthetic, recreation and tourism criteria. (Phillips 1969)

The limitations of the survey are apparent in the restriction upon the scope of the survey. The property economic aspects of the demand for the various varieties of land sizes had to be curtailed, due to inadequate time. Further data on the soil structure and sewage implications from residential development along the Cedara flats required a detailed investigation as this area drains towards the Albert Falls Lake. Scotney's work (1970) has become available only after the completion of the field surveys. Although he has contributed a wealth of information, additional field investigations of his proposed conservation areas, (Map 2J) should be undertaken. The Upper Karkloof forest and Podocarpus forest relics near the Karkloof Falls should be investigated, and the latter united to the recreation-axis proposals.

D. RECOMMENDATIONS

- (1) In keeping with the intrinsic land suitabilities, it is recommended that provision be made for a green open space, undeveloped natural landscape or woodlands system to encircle Pietermaritzburg and continue along the Umgeni valley and Zwartkop escarpment.
- (2) In keeping with the open space system's proposals and the socio-economic features, that (a) the two local authority areas of Sweetwaters and (b) Winterskloof be amalgamated, and that subdivisions exceed 2 hectares (5 acres).
- (3) In order to conserve and enhance the impounded water resources it is recommended that (a) the Umgeni-Karkloof gorges and valley be reserved for conservation and recreational use; (b) the periphery of the Umgeni Nature Reserve and Midmar Valley be reserved for agriculture to be controlled by the Department of Agriculture and Technical Services in order to prevent erosion; and (c) the area between the Midmar Lake and the Boston Road watershed be reserved for agriculture and not be allocated to residential use.
- (4) Arising from the close relationship between major dams and recreation it is recommended that representations be made to the Department of Water Affairs, to indicate the desirability of co-ordinated recreational and water-resource planning, particularly with regard to the purchasing of land on the margins of proposed dams.
- (5) Following from the absence of adequate scientific data it is recommended that:
 - (a) the desirability of making available more plots of varied size be investigated;
 - (b) the possibility of residential areas and high density development adjacent to permanent agricultural areas, such as Cedara College, be investigated.
- (6) With regard to the high demand for land and the population increase, it is recommended that Howick-West be expanded in the future (preferably up to the Boston Road) and that suitable representations to this effect be made in the appropriate quarters.
- (7) Taking cognisance of the probability of the pollution of a major water resource, and to a lesser degree landscaping considerations; the creation of a health hazard; and possible conflicts in terms of abutting high and low income areas; it is recommended that representations be made in suitable terms to the appropriate bodies, that no expansion of Zwartkop Reserve

or that no other Bantu Area be permitted in the Midmar Catchment Area, or in the area of white owned farms between the Umgeni Valley and Zwartkop Reserve.

CHAPTER 6 INDUSTRIAL LOCATIONAL ANALYSIS

6.1 OUTLINE OF THE PROBLEM

The problem arose from the desire of a promoter to develop an industrial township at Tweedie. In order to proceed with his intentions it was necessary for him to obtain the support and approval of a number of private concerns and public bodies. One such body was the Natal Town and Regional Planning Commission. The Commission's staff undertook a preliminary investigation into the question and this work represents a fuller and more comprehensive consideration of the problem.

The specific problem or question to be answered was: Should an industrial township be permitted at Tweedie?"

This is in fact a functional problem. Whereas the previous test for the ecological approach was to detect alternative or compatible uses for a given terrain, this second problem and test presupposes ^{the use} and the location or alternative locations must be assessed and specified.

It should also be noted that the scale of the enquiry has been reduced from the Lions River Study Region to the Howick Study Area, viz. the terrain in the lower South-East portion of the Study Region, and lying between Pietermaritzburg and Lions River, and stretching from Lake Midmar to Albert Falls dam, or Otto's Bluff.

The functional problem of an industrial locational analysis has been subdivided into a fuller three questions, or three sub-problems. The first question is where are the alternative sites in the study area where an industrial township may be developed? Has the promoter selected the most suitable or feasible site by physio-economic criteria?

The second question is to consider the comparative economic advantages of locating at the alternative sites. The question may be rephrased to consider whether the optimum site selected according to physical criteria will prove a sound investment. Is there any demand or need for an industrial township in such a location: what industries are likely to constitute this demand, and how important is and how favourably does the estimated selling price of the optimum physical site compare with alternative industrial sites?

After considering where the most feasible site is, and whether the proposal is economically viable, the third question or sub-problem is to assess whether such optimum, feasible and viable proposal is desirable to the community at large? What in fact are the social consequences of the proposal? Do the social costs or liabilities outweigh the benefits to the community and to the individual developer and purchasers? This last sub-problem is the most comprehensive of the three. Here a synoptic view must be taken in regard to the interaction of physical, sociological and economic considerations; and in regard to considering the three sub-problems together in order to arrive at a conclusion where an industrial township successfully can, and should locate.

As in the first application and test of the ecological approach, the historical method has been used to ascertain the critical considerations or variables and the facts, by means of testing and sifting the oral and written evidence of expert witnesses.

The test of the ecological approach was to detect the important inter-relationships, and obtain a reliable synthesis such that a series of panels of judges or experts would approve the conclusions and the manner whereby the conclusions were derived - in regard to the location of an industrial township within the study area.

6.2 LOCATIONAL FEASIBILITY SURVEY

6.2.1 MACRO APPROACH

Natal's industrial infrastructure or facilities are spread along two axes. Map 1 B shows that the primary roads, rail and dams are along the interior axis passing from the Durban complex through Ladysmith to the Witwatersrand market and secondly along the coastal axis passing through Durban. The Tugela, the Pongola and Umzimkulu are, in order of annual flow, Natal's most important rivers. These three rivers are to the south of the Witwatersrand growthpole, and flow predominantly through the rural areas of Natal. The concentration of industry in the Vaal triangle, with its restricted water resources necessitates the relocation of industry, particularly major water consumers, to areas of plentiful water resources (Thorington-Smith, 1960). Thus in the long-term the rural north-east portion of Natal could increase in importance industrially whereas in the short-term, the accent will remain on the developed axes.

The electricity power lines closely follow the two infra-structive axes (map 1 C). The 11Kv lines also extend into the southern portion of Natal. On the other hand, (map 1 D) the Bantu Areas are overwhelmingly in the rural areas of Natal. Further the Bantu Areas south of the Pietermaritzburg-Durban axis, occupy about 17% of the area of Natal, while accommodating approximately 33% of the Bantu in Natal with an average density in the region of 300 persons per sq. mile. This southern region has much to commend it for investigation as a future industrial development area. Map 1 D also indicates Border areas within 10 miles of Bantu Areas. Besides the areas remote from Bantu Homelands in northern Natal, a large non-Border area stretches almost from Weenen through Mooi River to Lidgetton in the south and extends to Greytown in the east. Thus the northern part of the study area falls outside a Border area.

In general terms the raw materials and predominant agricultural activities in Natal are shown on Map 1 A. The mineral wealth, including water resources, lies in a belt in the northern Natal midlands. Most of the mineral resources lie in a belt in the undeveloped areas.

6.2.2 MICRO APPROACH

(a) General

The same process of analysis was applied on the micro scale. The Main Road, Rail, power supply axis, water supply, Bantu and Border Areas are depicted on Map 3 A. These five prime infra-structural resources are essential to any industrial development. In theory it is possible to overcome the absence of infra-structural resources, or the disadvantage of being a considerable distance from a resource. In practice, transportation and other excessive costs make a site remote from services and labour unsuitable for industrial development. A small industrial area would require the resources to be in a more favourable mix than would be required for a major urban industrial complex, which could, by virtue of economics of agglomeration, overcome a weaker mix. A separation of ten miles between an industrial facility and a resource is taken as the maximum distance, while three miles and nearer has been assumed to be the lower limit, which a small industrial development would require or desire.

(b) First Feasibility Sieve : land near primary infrastructure

The water resources in the study area would be derived from the Umgeni river, flowing through Midmar Lake to Albert Falls Dam. At this stage the industrial requirements have been assumed to be able to be met.

Many factories can operate without a railway siding. Only one of the factories, for example, in the Pinetown-New Germany sector of Metropolitan Durban, has a railway siding, but as most industries rely on the railways for the transport of raw materials and delivery of finished products to the major markets, access to an attended station, where the necessary staff and exchange facilities are available, is very important.

There is a general 30 mile unrestricted radius for road transport. Beyond this distance individual firms have to show a definite necessity before the Road Transportation Board will grant an exemption. In considering the feasibility of a future industrial site in the Study Area, road transport alone cannot be assumed to be sufficient and good access to a railhead and preferably private siding facilities are considered essential for first stage development.

In general, Escom will supply electric power wherever the demand justifies the establishment of powerlines (the consumer pays for the sub-station to step down the voltage). The power lines in the area are quite adequate to support a small industrial development without any difficulty (Map 1C and 3A).

In order to co-ordinate development and conform to labour policy, industries should be established in Border areas and as near as possible to Bantu labour. Furthermore industries locating in Border Areas are subject to special considerations, depending on the nature of the industry and its location. Generally these considerations take the form of tax concessions, and lower interest rates for approved loans from the Industrial Development Corporation. Hence proximity to Bantu Areas has been taken as a prerequisite and included in sieve one.

(c) Second Sieve : flat land

Having isolated the land near primary services, the second sieve detects land with a slope flatter than 1 in 25 and between 1 in 25 and 1 in 10. It will be seen on Map 3B, that a large amount of flat land is in close proximity to the transport power axis.

(d) Third Sieve : land economical to service

The third sieve isolates land economical to service. The prime requisite was railway siding services. A reconnaissance; and investigation with the Railway District Engineer was undertaken into both the relative cost and feasibility of laying a track to the site concerned and secondly in servicing the actual site. The most promising sites (see numbered sites on Map 3B), were then considered, bearing in mind the following railway requirements:-

(i) Sidings may only originate from 'attended' stations from the side of the station from which the goods yard is situated. In no circumstances may sidings be taken from the railway outside the limits of a station;

(ii) Maximum gradient: 1 in 50, reduced on curves by 0.04 ft., per degree of central angle subtended, to compensate for friction of curvature, and

(iii) Minimum radius for curves: 450 ft., or in special circumstances and if check-railed 350 ft..

So far as railway requirements are concerned, individual factories can frequently be sited on undulating land and satisfactorily serviced with sidings. Where the land slopes are fairly steep the siding may have to follow the general circuitous line of the contours, but if the site is large it is often possible to select a limited number of favourable positions adjoining the railway route, on which buildings can be erected.

If, however, it is desired to site a number of factories compactly in an industrial estate, the problem is different.

To attain a reasonably compact form of development it is necessary for the road and siding systems to be so arranged that factories may front on to both sides of the roads and back on to both sides of the exchange sidings. To achieve such an arrangement it must be possible to deploy the exchange sidings along the contours and still observe the maximum gradient of 1 in 50 across the contours for the service siding and as normal railway practice is to approach and deploy sidings diagonally, it follows, therefore that the general slope of large industrial estates which are to be serviced with railway sidings should not exceed 1 in 25, although naturally, minor infringements of this slope can be overcome without undue difficulty or expense by modification in direction of lines or by earthworks.

RAIL ACCESS

The following potential industrial sites shown on Map 3B were investigated, with reference to the feasibility of providing rail access.

SITE 1 and 2 CEDARA. to the north of the line: All rail access must be taken off the right-hand side, looking towards Lidgetton, from all stations in the area. There are very high banks across Cedara Gorge and cuttings at Cedara station. These make it too uneconomic to have access from Cedara station. Site 1 has only a small area with slope less than 1 : 50 and site 2 has the further disadvantage of having smallholdings on the flat area. The cost of buying the smallholdings would make the return on the capital outlay too small, with only a few sites able to be served by rail facilities.

SITE 3. Besides the very uneconomic cost of widening Cedara cutting and the position of the national road, site 3 is on Cedara Agricultural College, and is thus eliminated.

SITE 4 lies to the south of the national road: access would have to come from Merrivale Station. This site would require alternations to the Howick line and rail access under or over the double railway line and National Road. The cost would be in the hundred thousands of Rands before a track was laid on the site. The grades are too steep to permit good servicing, and prevent linking areas 4 and 11 without tunnelling or other heavy expenditure.

SITE 5 lies on the Howick Gold course. Rail access to this site is out of the question, due to the excessively steep gradients, and landscape requirements.

SITE 6 The Tweedies site. Restricting the development proposal to half the usable land avoids the costly crossing of the Main road. This is the one site which is clearly feasible to service economically with rail facilities.

SITE 7 This is complementary to site 6, being 'Banff' farm, on the other side of the railway line from site 6. This site would require an over or under pass to the double railway lines. This site, though feasible, would be more expensive than site 6. The southern portion of site 7, below the old Main Road. lies across the watershed from site 6, and as it is visible from the Midmar Lake it would be highly undesirable. If it is to be developed as an industrial area severe restrictions would have to be imposed.

SITE 8 Lions River, would be a difficult position from which to have rail access. Firstly there is not much space between the railway line and road. The line would require a cutting to reach site 8 which is waterlogged swampy ground. The land across the road from site 8 would necessitate rail access across the old National Road, to a small area, with high water content in the soil, and still within the Midmar Dam sphere of influence.

SITES 9 and 10 can be ruled out as uneconomic : a causeway across Lions River and Marsh (site 9) and access across the old National road would all be necessary.

Beyond Dargle the area becomes too far from the Bantu areas. Besides the distance from the Bantu areas Lidgetton has flat land on both sides of the Railway line. A siding would have to come off the side next to the National Road, across the National Road to the smaller flat area. The line is about 25 feet above the road; earthworks and bridges would be necessary. To the left of the line, are smallholdings. This area could only be considered for a very large industrial development, which would warrant the expenditure required.

Thus site 6, with site 7 as second phase development is the only economical area to service.

(e) Fourth Sieve: Water Resources and Agricultural Areas.

WATER

Although Midmar water resources were investigated, no definite answer could be obtained to the question as to whether the water capacity from Midmar made provision for industrial development in the area.

Table 13 in Thorrrington-Smith (1960), has a constant figure of 0.022 million gallons of water per industrial acre, consumed per day. This figure applies to Durban, Johannesburg, and Pretoria. Thus a site of 100 industrial acres would make an additional demand on the water resources, of the order of 2.2 million gallons per day. This is approximately Pietermaritzburg's present requirements from Midmar, which fluctuate between 0 to 5 million gallons per day (m.g.d.).

It is estimated that by 1990, or 2000 A.D. Midmar's water resources will be fully utilised. Pietermaritzburg would use approximately 30 m.g.d. and Hammarisdale and environs 36 m.g.d., out of a total capacity of 66 m.g.d.. It would appear therefore that provision for water is adequate.

AGRICULTURAL GRADING

An agricultural assessment of the possible industrial sites was undertaken on the basis of (a) agro-ecological potential and (b) actual agro-economic potential which considered such factors as optimum area for maximum agricultural productivity, and the transport network. Each site received an agricultural index and was ranked alphabetically according to agricultural desirability and potentiality, viz. an A ranking should be preserved for agriculture while a K grade could well be utilised for non-agricultural use.

ASSESSMENT OF SITES ON MAP 3B

SITE 1 is the Cedara promontory to the north of the National Road. Rating H as it has poor soils and drainage.

SITE 2, the Merrivale flats, were awarded an I grade. Although the soils are good the uneconomic subdivision of the area into smallholdings renders it agriculturally undesirable.

SITE 3, Cedara flats or Cedara agricultural college, has an A rating.

SITE 4 between the National Road and the Boston Road, and below the Boston Road Ridge, was allocated an E rating, with good soils although it falls into the rain shadow area.

SITE 11, the flat land on "La Marne", was defined with a C ranking. It is on good soils and is an economic size for agriculture.

SITE 5, the Howick golf course, received a K rating, i.e. it should be the first site to be used for non-agricultural use.

SITE 6, the feasible Tweedie industrial area, obtained a J ranking. The area is bisected by road and rail and has therefore small agro-economical potential. This area is therefore the second most desirable area for non-agricultural use.

SITE 7, 'Banff' farm, alongside the Tweedie feasible industrial site. The good soils are counterbalanced by the spatial fragmentation resulting from the transport network. It derived an F grading.

SITE 8, near the loop in the railway line, was awarded a D index as the soils above the line are good.

SITE 9, on the farm 'Windfall', on the Lions River vlei, received a G ranking, as the vleis are subject to flooding.

SITE 10, to the East of Dargle station, was given a B rating. The area thus has the highest agricultural potential of all the sites considered. The soils are good, it forms a large agricultural unit, and has high agricultural potential.

IMPLEMENTATION.

The following sites were selected as having a low agricultural potential, and could therefore be utilised for non-agricultural or industrial purposes:-

- (i) Howick Golf Course, site No. 5 - K.
- (ii) Tweedie feasible, site No. 6 - J.
- (iii) The Merrivale Flats, site No. 2 - I.
- (iv) N.E. of Cedara flats, site No. 1 - H.

It should be concluded therefore that -

- (a) the Tweedie site has a low agricultural potential and could well be used for industry from the criterion of agriculture.
- (b) The adjoining area on 'Banff' farm, however, has a medium agricultural ranking, and should be viewed with more caution.
- (c) The farm "La Marne", site No. 11, has the third highest agricultural potential in the survey. It should therefore be definitely preserved for agriculture.

6.2.3. CONCLUSION ON INDUSTRIAL FEASIBILITY

The Tweedie site (No. 6) with a possible extension on to "Banff" farm (site No. 7) is the area with the highest feasibility rating in the Howick Study area.

6.3. TWEEDIE SITE : ECONOMIC VIABILITY OR ECONOMIC LOCATION ANALYSIS

6.3.1. DESCRIPTION OF THE TWEEDIE SITE

Site No. 6 on Map 3B, situated west of Howick, over the watershed of Midmar Lake, adjacent to Tweedie Station, half-a-mile from the National Road and traversed by the old main road from Howick to Tweedie. The site is, therefore, well placed in relation to the transport facilities from the Witwatersrand to Durban.

6.3.2. LOCATIONAL ECONOMICS

(A) GENERAL LOCATIONAL COSTS

Having considered the relationship between the site and the location of the infrastructure, the question is "what type and number of industries, if any, would be prepared to move to a possible industrial area in Tweedie?".

The Pietermaritzburg-Durban region is a relatively industrialised area, apart from the Bantu reserves which have no industry at all. Agricultural employment in the region (again excluding the reserves) is less than half the industrial employment.

It should be borne in mind, however, in any assessment of the relative importance of industry as compared with agriculture, that some of the raw materials used by industry in the region, come from the agricultural sector, e.g. food, tanning extract, wood processing. The early stages of the region's economic development were characterised by the processing of locally-produced agricultural raw materials for export. These industries were the primary means of attracting capital and were the earners of sorely-needed foreign exchange. It was the production of sugar and later wattle, which provided the basis of these industries.

Commercial and industrial enterprises normally seek to make the maximum profit and can therefore be expected to develop at the position where production costs are least.

TRANSFER AND PROCESSING COSTS

The cost factors of location may be separated into two groups, transport costs and production costs. Costs of obtaining the raw materials and of distributing the finished products are considered as transport costs, while agglomeration forces

and institutional cost factors are treated as partial determinants of production costs.

Industries try to avoid the expense of obtaining raw materials from a distance and inconvenience of distributing to distant consumers.

Because terminal costs and other expenses are independent of the length of haul, freightage increases less rapidly in proportion with distance. This favours location at a terminal point rather than an intermediate position and in a production process involving a single material and single market a location at the source of material or at the market would be beneficial, rather than at an intermediate point.

If freightage is a significant factor, the site where this is lowest will be selected. Whether this site is at the point of consumption, at the source of raw materials or fuel, or at some intermediate point, depends on the characteristics of the product : a weight losing process will be attracted to the source of the materials and a weight gaining process favours location near the market. When more than one raw material is used an intermediate position may be the point of least freightage.

Labour cost in different localities only exerts a significant locational pull, whenever the savings on this account exceed additional freightage.

In general, the early stages of production are material-orientated and later stages market-orientated, while intermediate stages tend to be relatively "foot-loose".

If processing involves a substantial loss of bulk and if freight rates for materials and products are at all comparable, industries tend to locate near raw materials.

Orientation to markets may be based on weight gain in process of manufacture or on higher freight rates on products than on materials.

The greater the number of materials used and the nearer the manufacturing process approaches to the finished article, the more important is a position close to the market.

The closer a factory is to the main market for its products the lower the transport cost of the products and the less the cost of communication between customers, the sales organisation and the factory.

South African commerce is dominated by the Witwatersrand market which is more important than the coastal markets of Cape Town, Port Elizabeth and Durban, combined. The study area is a decentralised position some distance from one of the major markets and at a much greater distance from the others. In this position industry would be exposed to the inherent disadvantages associated with the decentralised location of factories. Among these are the high proportion of trunk calls, difficulties in attracting skilled labour and lower productivity of unskilled labour, need to carry larger stocks of materials, lack of contact with others in the same industry and difficulties in providing after-sales service since most sales are in metropolitan areas.

"The decentralisation of industry within and around an industrial complex is desirable and usually practicable from a planning point of view. The crucial limiting factor is the market. It will take several generations before the present pattern of widely separated highly concentrated markets centred on the metropolitan areas, diffuses sufficiently to attract industry away from the cities on any appreciable scale". (Industry in Greater Durban Part II, McWhirter).

The reduced amount of purchasing power in the area must militate against the establishment there of market-orientated industry, particularly as with the growth of the South African economy, an increasing number of industries are now able to support separate factories at each of the main consuming centres.

(B) RESOURCE ORIENTATED INDUSTRIES

In considering the prospects for industrial development in the Study Area an obvious starting point is availability of resource base upon which material orientated industries could develop.

GEOLOGICAL MATERIALS: The only major activity is the quarrying of dolerite at Hilton and Pietermaritzburg and the manufacture of bricks at Pietermaritzburg.

AGRICULTURE is based on sugar, trees (wattle and timber) and dairying.

SUGAR: (Dalton-Wartburg area) focussed on the mill at Jaagbaan.

TREES: Wattle: No new industry can be expected from the manufacture of wattle tanning materials. The prospects for the export of wattle wood chips are more encouraging.

TIMBER: Although timber plantations are expanding rapidly sawmills will be as close to the plantations as possible. The Tweedie site was one of a number of sites whose suitability as a site for a pulp and paper mill was investigated but transport costs to the port, atmospheric pollution and effluent disposal problems have caused the mill to be built in two positions, at Creighton and Durban. In view of this it seems unlikely that there will be a need for another mill in the region for many years.

DAIRYING: This is hardly an activity leading to significant industry, particularly when primarily intended for fresh milk production. Such industry as would develop would moreover not generate growth, but would follow the general economic expansion of the area.

Other resources are water, proximity to the port and city of Durban, and population.

WATER: Apart from the need for reticulation a supply of water is no problem in the area.

PROXIMITY TO DURBAN:

This is an attraction to industries:-

based on imported raw materials; or
orientated towards exports.

An additional advantage is that Durban is a market for manufactured goods. (The Study Area is, however, outside the Durban exempted area for road transport).

LABOUR MARKET

The quality and quantity of potential labour in the area and availability of inducements in terms of the Government's Border Industries Policy may be a decisive factor in initiating development.

As far as numbers are concerned the area has a rapidly growing Bantu labour force. In terms of Government policy the area is not a growth area or regional group area for Indians.

White labour is not so readily available and skilled workers might, in the absence of skilled non-Whites, be difficult to find.

(C) SUMMARY

In consultation with an industrialist and municipal officials the following points emerged:

- (i) A sophisticated theoretical industrial locational analysis for Pietermaritzburg was considered to be invalidated by actual development. A complex locational analysis was

not therefore conducted, but a list of Locational

d Determinations follows.

- (ii) There should be a developed infrastructure of schools, houses, etc. in the two for two reasons. Generally the industrialist is not prepared to invest his productive capital in housing. Secondly, if the social amenities are lacking, or it is considered an unattractive town, the industrialist will be unable to attract essential skilled labour. A suitably developed infrastructure and social amenities are reputed to be available at Howick.
- (iii) As the power-transport axis covers most of the towns in the Border Areas, Government policy and concessions often prove to be the critical determinant. Whilst not implying approval, the Department of Planning has indicated willingness to permit some industry to be established at Howick, provided the Provincial Administration is satisfied that this would be desirable.

At the Tweedie site the advice is that locational stimulus would be provided by subsidiary concerns to Messrs. Goodwood Timbers Ltd. or allied firms in the field, for example of plastics, prefabricated housing, furniture, frozen food and packaging, light engineering and textiles.

It was stressed that recent industrial arrivals at Pietermaritzburg have not been necessarily sited with regard to their need for raw materials. McWhirter in N.T.R.P.(1959), found that the locational effect in Durban of South African industrial raw materials is almost negligible.

Both Howick and Pietermaritzburg are on a direct axis to the reef and benefit from Border Concessions, and by not having a corrosive climate; and their site costs are lower than Durban, as may be seen in table 3, below.

TABLE 3. PRICE OF INDUSTRIAL LAND

Area	Average price per acre Industrial Land	
Durban	R40,000 - R50,000	
Pietermaritzburg	R5,500	With rail facilities R8,000 - R12,000
Tweedie	R6,000	With rail facilities R12,000
Source : Estates Dept. Pietermaritzburg Municipality		

(Note: The R6,000 per acre price for Tweedie, it is explained, is an average. The sites would be sold at R4,000 per acre at the present time increasing to R8,000 after a number of years).

Pietermaritzburg is within Durban exempted area for motor transport, Howick and Tweedie are not. This could prove to be a very serious disadvantage.

Although industry is being attracted to Pietermaritzburg, a large amount of serviced industrial land and even greater amounts of potential industrial land are available in Pietermaritzburg. The Tweedie site would thus have to compete with the Capital for industries, as is shown in Tables 4, 5 and 6 below.

TABLE 4. INDUSTRIAL GROWTH OF PIETERMARITZBURG

Year	Acres Sold	INCREMENTAL EMPLOYMENT			
		From new industries		Established industries	
		Whites	N/Whites	Whites	N/Whites
1963	4				
1964	9				
1965	40				
1966	67				
1967	22	500	3,000		
1968	20	407	1,420	500	1,500
1969/70	175				
Total	338	± 900	± 3,400	500	1,500
Source : Estates Dept. Pietermaritzburg Municipality					

TABLE 5. INDUSTRIAL LAND - PIETERMARITZBURG

to 1969 : INDUSTRIAL LAND		Acres
Developable land for industry:		
(a)	Willowton	2,000
(b)	Mason's Mill	800
(c)	M'Kondeni	<u>600</u>
	Total developable industrial land:	<u>3,400</u>
<u>Less</u>	land developed for industry	338
	Balance still available for industrial development:	<u>3,000</u>
Source : Estates Dept. Pietermaritzburg		

TABLE 6. INDUSTRIAL LAND - TWEEDIE

Tweedie	Gross Acres
Area for development	112
Maximum developable	300 - 600
Source: Estate Dept. Pietermaritzburg	

In conclusion, although Pietermaritzburg City possesses a large surplus of land available for industrial development, the Tweedie site possesses competitive qualitative advantages, e.g. climate, cheap labour and possibly a competitive Selling Price. The next section considers comparative 6.2.3. land Price estimates more closely.

6.3.3. COMPARATIVE LAND PRICE ESTIMATES

A. PROPERTY PRICES

Messrs. Keeve, Steyn & Partners produced a preliminary feasibility report for the site in which they estimate that the

Total gross area of site = 155 acres

Net development area = 112 acres

viz. 72% of the gross area is available for industrial sites.

Furthermore, they estimate development costs (excluding purchase price of the land) for the whole site to be in the region of R1,070,000. As the developer estimates his total costs for rail services on half the site to be between R400,000 - R500,000 and with the Provincial Administration paying for the access roads, this would indicate a maximum price of R4,000 - R5,000 per net industrial acre, to which could be added the cost price of estimated R500 p.a., i.e. sale price is R4,500 - R5,500 p.a.

The entrepreneur has quite definitely stated that as the developer "he is aware of the environment of Midmar and wishes to preserve it"; in order to do this he would create a "garden industrial township with a maximum of 80% utilization" and insist on clean industries.

As the consulting engineers have shown, the residual area after making provision for roads and rail, is only 72% of the aggregate site. With 20% of the area remaining devoted to gardens the result would be to increase the sale price of the usable industrial land by the same amount.

TABLE 7. ESTIMATES FOR SALE PRICE OF TWEEDIE INDUSTRIAL LAND

	Rail Facilities Rands per acre	No Rail Rands per Acre
Developer's Estimates	R12,000	R6,000
Derived estimated minimum	R8,500 - 10,500	
Garden industrial minimum	R10,200- 12,600	
Estimated Pietermaritzburg Industrial Plot prices	R8,000 - 12,000	R5,000 +
(Note: The R6,000 per acre price for industrial land without sidings at Tweedie is an average. The sites would be sold at R4,000 per acre at the present time increasing to R8,000 after a number of years).		
Source: Developer and subsequent calculations		

It would thus appear that Tweedie is pricing itself out of the market, without even allowing for any profit or return on capital investment, unless it is already hidden in the road and rail development costs.

B. CONCLUSION

The demand for industrial sites in the area cannot be estimated with any large degree of accuracy. But if the developer prices his land significantly above the market price in Pietermaritzburg, he is likely to decrease considerably such demand as there might be for his industrial lots.

6.4 PRELIMINARY INDUSTRIAL DESIRABILITY ASSESSMENT

6.4.1 AESTHETIC AND RECREATIONAL CONSIDERATIONS

Midmar Lake is the premier recreational area in the Natal Midlands, within striking distance of a third of Natal's total population, the majority of whom, however, are too poor to be able to afford to visit the Lake.

It is rather difficult to reconcile industrial development alongside a nature reserve, and public relaxation area. In Chapter 6 under recreation this work makes some important proposals to enhance the desirability of this amenity. It has been suggested that the Tweedie industrial layout be given garden treatment. It is doubtful whether the planting could be on such a scale as to transform the industrial site, into a garden industry, that still remained an economic proposition.

6.4.2 EMPLOYMENT CONSIDERATIONS

A. Labour Market : General

The limited employment opportunities in Howick have placed employers in a monopsonistic (many sellers one buyer) position. They are therefore able to - firstly, maintain low wages, due to absence of competition, and secondly, afford large fluctuations in employment (see Table 8).

TABLE 8. MONOPSONISTIC EMPLOYMENT FIGURES

Date	Bantu Males	Total non-Whites
June, 1967	1,774	-
July, 1968	1,838	-
February, 1969	1,876	-
January, 1970	1,600	2,013
Source : Bantu Affairs Dept. Howick		

This instability in the employment market is reflected in a low standard wage of R8.00 per week for new Indian labour. It was impossible to gain any reliable indication of non-White unemployment for the region.

In the short-term, the distance from Pietermaritzburg reflected in travelling time, travelling cost and inadequate market information tends geographically to isolate the labour market. In the long-term, local labour should migrate to the urban centres for employment, attracted by higher wages, although higher land prices (e.g. Raisethorpe), higher cost of living and

unwillingness to move, will reinforce labour's tendency to be immobile.

B. LABOUR REQUIREMENTS FOR TWEEDIE

The following employment increase resulting from the sale of additional land has been of the order of 13 persons per additional net acre. If this labour quotient were applicable to Tweedie it would provide employment for approximately 1,300 more persons of all races.

Secondly the Department of Bantu Administration and Development estimate worker density to be about 20 persons per net acre, viz. 2,000 Bantu. At an average of 1.3 workers per family 2,000 persons would represent 1,538 families, or 1,538 additional houses needed in Mpophomeni. Taking the figure of 7 persons per family the 1,538 families represent a total increase of Bantu population resulting from industry, of approximately 10,760 persons.

It is possible that the workers will leave their families in the Bantu rural areas, but the argument in favour of industry rests on the principle that industry will provide employment for the unemployed from the families, in Mpophomeni (Bantu Township on the farm Montrose near Midmar Dam). Furthermore, as the industries would be in a border area, it would be most desirable to preserve the family unit.

Thirdly the promoter provided tentative figures of future employment, which are included in Table 9, below.

TABLE 9. PROMOTER'S EMPLOYMENT ESTIMATES

Type of manufacturing concern	Year	Employment	
		No.	Increase
Midmar Plastics	1968	28	0
Consolidation Plastics Factories	1969	65	3
Frozen Food Packaging,)	1970/71	150	85
furniture (3-4 other firms)	1972/73	300	150
* (Total own labour 800))	1973/74	1,200	400
(8-12 new firms)(Estimated Total Own Labour 1200)	1985	3,000	1,800
Source : Promoters' Estimates			

Using an employment structure of 7 Bantu : 2 Indians : 1 White this table represents 2,100 employed Bantu, which already exceeds estimate (ii) ante. As the figures in the table do not represent use of the whole site by industry, total Bantu employment would, therefore, on this basis, ultimately be much higher. The increase in employment (1973/74) in the table, were it to occur, would suddenly put considerable pressure on the service infrastructure of the surrounding area.

C. CONCLUSION

Mpophomeni Township was established to re-house Bantu labour employed in Howick and re-habilitate Bantu squatters on agricultural land.

Although there are no reliable estimates of non-White unemployment for the area, it is to be doubted whether unemployment approaches the figure of labour required at Tweedie in the future.

The estimates of labour requirements demonstrate that industry attracts labour, which creates an additional demand for housing. As Mpophomeni is already sited on the slopes of Midmar Lake (Map 3B), ~~ie.~~ ^{therefore} it falls within the watershed of the lake and is topographically isolated from adjacent areas, it is therefore imperative that the township be contained in the existing area. Considerable planning difficulties and hazards to health would result from any extension of Mpophomeni.

If a major industrial township were to be established there can be no doubt that the Bantu Affairs Department, under existing conditions and a building rate of 100 houses a year, would be unable to provide adequate housing for persons employed in industry at Tweedie. ✓

6.4.3 POLLUTION

A. GENERAL

The whole question of pollution is complex and critical. Generally pollution occurs in solid and liquid states, usually from industrial effluent, faecal disposal, or waste disposal; insecticides; thermal and radio-active contamination. This work is concerned with industrial and faecal disposal, the results of which are usually visible to the eye, but the actual process invisible. Generally pollution of the elements occurs

particularly in water and air. It is the insidious nature of pollution which makes it so dangerous.

B. ATMOSPHERIC POLLUTION

Smog is perhaps the most commonly recognised type of industrial pollution. Wind readings, see table 1, indicate that the general wind directions are reversed in summer and winter. Industry on either side of Howick could therefore be hazardous. In valleys lying in a north-west to south-east position, Tyson (1966) maintains that "direction of the mountain wind is less a function of local valley orientation than of large-scale relief between the Drakensberg escarpment zone and the flatter areas of the Natal Midlands to the south-east. The profile will, therefore, be controlled in the lower layers within the valley by the local pressure gradients in the valley, while at ridge level and above, the profile is more a function of the pressure gradient between the mountain and the plain, as happens in the Umsinduzi and Umgeni valleys and in the valley of a Thousand Hills".

Tyson (1963) shows that there is both a seasonal and daily concentration or dispersal of pollution. He makes the point that because of differences in bearing and wind movements, pollution differs in plains and valleys. He concludes "it is obvious that although the same basic meteorological parameters affecting atmospheric pollution obtain over both level and hilly ground, their effects can be very different. Inversion of temperature produces an increase in stability and a decrease in diffusibility over any terrain, but the frequency and intensity of these is greatly increased in hilly areas. In hilly country the complete dominance of the local climates by topography is the main factor responsible for bad pollution, macro-climatic factors having relatively little effect. Over flat ground, however, the reverse tends to obtain."

He continues, "today, in South Africa, as industrial expansion increases, it is essential that responsible town and regional planning bodies take cognizance of the fact that it is necessary to undertake microclimatic surveys before new development takes place. Only when this is done will the future effective control and abatement of atmospheric pollution become a reality".

The regional topography is diversified. This pattern is accentuated at Howick - Tweedie, where the flat expanses of Midmar are adjacent to rolling hills and the Umgeni Gorge. These topographical conditions add to the complexity of the macro and micro wind movements and pollution.

Secondly the water impoundment at Midmar, or along the Umgeni River valley, should most emphatically, not be polluted. Further atmospheric pollution would be most undesirable to the population residing in the Howick area or the Umgeni valley. Chemical disposal whether visible or invisible would also be most disadvantageous both to agricultural experiments at Cedara, and the Umgeni Valley vegetation.

In conclusion, because of the topography, the danger of polluting environment, and the fact that pollution may be chemical and invisible or in the form of smog and visible, a microclimatic survey is recommended before any industrial development is permitted in the Howick Study Area.

C. AQUATIC POLLUTION

The dangers of water pollution have been considered under the industrial heading, although domestic sewage is always a danger to water supplies.

Chemical pollution can operate from industries situated in the watershed or margins of domestic water impoundments. In his memorandum Dr. Jackson (1970) stated, "Certain chemicals due to their inherent toxicity or their effects at certain concentrations are capable of interfering with the natural biological agencies, through and by which water is capable of effecting its self purification".

Dr. Jackson further pointed out that the influence likely to produce or cause the health hazard may operate from within the watershed, or on the margins of water impoundments. Clearly it is necessary to be alive to this danger, with regard to Midmar Lake and the proposed Albert Falls Dam.

The danger of pollution at Midmar arises also from purified or unpurified domestic sewage from residential areas being fed into the water impoundment, or sewage from septic tanks leaking into or being carried into the water impoundment by underground water. Dr. Jackson states, "In many parts of the world the uncontrolled discharge of domestic sewage, treated and untreated, directly into and, or on to the watersheds of large natural and artificial water impoundments has brought about a state of

eutrophication, characterised by the growth in the water of a variety of green algae. This phenomenon would seem to be a result of the phosphate concentration of the water being raised above a critical level, while at the same time the pollution has produced an associated increase in the nitrogenous content of the water."

Beyond this stage "further exacerbation of the pollution is likely to bring about this serious and dangerous overall aquatic effects" This change in the hydro-biology is often heightened in the dry seasons when the quantity of water decreases.

The death of Lake Eyrie is an infamous example of large scale pollution (Charlier, 1969). In a paper presented to the Institute of Water Pollution and Control McKendrick and Williams (1968) discuss the dramatic and dangerous effects of urban drainage on Lake McIlwaine, outside Salisbury, Rhodesia. They submit that the considerable eutrophic action or blooming of the algae resulted from the introduction of sewage effluents and urban wastes containing high nitrogen and phosphate amounts into the relatively static water body. After the difficulties experienced with the deterioration in the water quality, they continue "it was realised that a more detailed investigation of the problem was necessary." It was accordingly decided:-

- (i) to check all previous reports and analyses
- (ii) to investigate the cause and characteristics of the lake algae
- (iii) "to carry out analyses of all water entering the lake, as well as analyses of the water at different points of the lake, and at different depths, and
- (iv) to study the limnology of the lake."

McKendrick and Williams conclude:-

- (a) that the ideal remedy would be to prevent sewage effluents containing nutrients entering any lakes or dams, but that this would probably be a practical impossibility
- (b) that consideration must also be given to the siting of raw water intake points feeding water treatment works.
- (c) "Research is essential, possibly on a national scale, to find methods of removing these nutrients from sewage effluents by economical means. If this is not done, then as Rhodesia grows and develops it can be expected that many more lakes and dams will experience conditions similar to those existing in Lake McIlwaine."
- (d) "Insufficient consideration has been given to the hydro-biological aspects of dam construction, which must take equal importance with the normal hydrological aspects to which, up to the present, attention has been directed almost exclusively."

Two additional points should be borne in mind; that the urgency for water conservation is much greater in South Africa; and that unless action is taken eutrophication and pollution of major water impoundments near urban areas, can be reasonably expected to occur in the future.

Middleton and Kokot (1961) lead a survey into the water resources and water requirements of the Umgeni River. This was followed by a study of water quality and abatement of pollution in the rivers of the Three Rivers Region (N.I.W.R., 1967 vol 1 & 2).

In conclusion, the vital function served by the Midmar and Albert Falls water impoundments, together with the quite different conditions pertaining to dams and to rivers necessitate a thorough hydro-biological and hydrological survey of the two water impoundments. The survey should establish the quality and quantity of pollution entering; the absorbant threshold, and the properties of, the Midmar and Albert Falls water impoundments, so that significant and major pollution may be avoided.

Industry at Tweedie would thus have the unfortunate consequences of -

- (a) inducing or supplementing Howick's industrial effluent and sewage disposal into the Umgeni. A sewage farm on the Karkloof Road is being investigated initially to serve the smaller subdivisions in the centre of the town. Effluent would be discharged into the Umgeni, below Midmar Lake, but which would feed into the domestic water impoundment at Albert Falls Dam;
- (b) raising the growth rate or size of Mpophomeni. This would increase the quantity of purified sewage from the township deposited into Midmar Lake, and this discharge of domestic sewage is likely to reduce serious overall effects if the pollution is maintained and increased. Finally "it must be accepted that despite the efficient treatment provided by a standard sewage treatment works, the final effluent from a works adds pollution to any stream, river, or water impoundment".
- (c) Midmar Dam falls within the altitude where the snail vectors of human and animal bilharzia may be found. At present it would appear that Midmar is free from these snails and "will remain free of them provided the existing aquatic ecology is preserved, or remains relatively undisturbed", i.e. unpolluted.

Although purification of the water should eliminate the transmission of typhoid, there is no certainty that water purification eliminates the transmission of polio.

D. CONCLUSION

Before industry could locate in the area a microclimatic survey should be undertaken to ensure the avoidance of unpleasant or disastrous effects on the environment and community.

As Midmar is a prime recreational and domestic consumable water impoundment, it is essential that pollution and the ensuing eutrophication and bacteriological dangers be avoided. A detailed qualitative and quantitative survey of the Midmar and Albert Falls impoundments is thus strongly recommended. The eradication of dangers, once established, as the Great Lakes and Lake McIlwaine have shown, can be very costly.

Dr. Jackson (1970) concludes, "therefore, where pollution of water is concerned, reasoning and experience would suggest the need for any country, and South Africa in particular, to protect certain water impoundments as far as it is feasible, against urbanisation, industrialisation, and pollution of their drainage basins".

6.4.4. COMMUNICATION NETWORK AND INFRASTRUCTURE

A. GENERAL

Messrs. Keeve, Steyn and Partners show in their report two possible routes from Mpophomeni to the industrial area. Neither route passes through the White residential area or Howick. Both routes run from the Boston Road to Midmar interchange: Route 1 along the watershed and Route 2 close and parallel to the National Road, through Howick West.

As the Department of Bantu Administration and Development is not in favour of Bantu transport passing through Indian areas, Route 2 must be eliminated. Both suggestions recognise the need to segregate commuter traffic from the rapid transit National Road by means of a service road.

Route 1 provides a link between the Boston Road and Midmar Reserve, which is apparently functional, except that in order to maintain control over the recreation area by means of as few entrances as possible, the route would have to bypass the Midmar Reserve. The costs for road building are estimated to be:-

- (a) R100,000 from the Boston Road to Midmar interchange;
- (b) R50,000 from Midmar interchange, along the Old Main Road to its junction with the Howick-Tweedie link;
- (c) R40,000 for the access road to the industrial area;

Thus, total Provincial expenditure = R190,000.

As the Old Main Road passes close to the dam it was suggested that it could pass under or over the National Road, but this would be inordinately expensive as it would cross the National Road twice.

Besides the provision of new, and the improvement of existing roads, industries at Tweedie would demand a considerable extension of services by the local authority and the Provincial Administration. Provision would have to be made for the disposal of industrial effluent and sewage; although this is already being contemplated by the Howick Town Council the necessity for storm water drainage and firefighting should not be overlooked. The provision of houses for employees, and schools for children, and numerous other hidden costs would have to be borne by the community, possibly in the form of increased rates.

B. CONCLUSION

Although all necessary services could be provided for the Tweedie industrial area their cost, which would be the responsibility of both the local community and the Provincial Administration, cannot be justified by the doubtful benefits to be derived by the general community from the presence of an industrial area at Tweedie.

6.5 CONCLUSIONS AND RECOMMENDATIONS

6.5.1 DISCUSSION OF PROBLEMS ARISING

The test was to consider the location of industry in the Howick Study Area, and as such was divided into three parts: location analysis in terms of feasibility, viability and desirability.

The industrial feasibility analysis necessitated considering the following factors: industrial site requirements, such as flat land or provision of basic services; railway engineering and the agricultural capability of specific sites. This last factor required both a knowledge of the particular sites agro-capability, and also the importance of the sites in relation to the overall Study Region. In order to obtain accurate and reliable data on these factors, expert opinion was consulted, co-ordinated and checked.

The viability analysis, the second sub-problem, demanded a knowledge of location economics to determine the resources and factors likely to influence the quantity and type of industrialist who could locate in the Study Area. (These qualitative and quantitative aspects were also important in performing the desirability analysis, for example, food processing pulp and textile manufacturers are major pollutants). In estimating the land sale prices, a knowledge of property economics, layout and detailed railway engineering was involved.

The desirability analysis was primarily a detection, isolation, synthesis and evaluation of the factors co-acting and reacting with the proposed development. As such, sociological and economic criteria were considered. These in turn lead to the detection of the serious problem of pollution, atmospheric and aquatic, and problems of communication and provision of infrastructive services - both of which involved engineering considerations. A sequence or web of inter-relationships co-actions and reactions between the criteria and parts of the problem were established in order that a synoptic view of the proposal might be obtained.

6.5.2 CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The results of the Feasibility and Viability analyses showed that although the Tweedie Area is the most feasible site for industrial development, it may well prove to be expensive to develop, for both the entrepreneur and the community.

The final part of the industrial location test was the desirability analysis. This showed that the development of an industrial township in the Howick Study Area is without need, and is undesirable for the following reasons:

1. The use of the site for industry would conflict with recreational and residential uses.
2. (a) Mpophomeni Bantu Township is intended to house the labour supply of Howick and not be an expanding labour pool for industrial expansion of other areas.
- (b) The amount of unemployment in any event could not be established with any certainty.
- (c) Rise in demand for labour would necessitate expanding the population of Mpophomeni with adverse effects on Midmar Lake both as a recreational area and water impoundment, and also on the racial residential development of the study area. *When Bantu Admin. comes*
- (d) The Department of Bantu Administration is not meeting the present housing demand: far less an enlarged demand.

3. The danger of aquatic and atmospheric pollution by industry and intensive residential development, is likely to be magnified by industrial development. ✓
4. (a) The infrastructure and hidden costs compare adversely with possible social benefits, arising from the industrial township. ✓
- (b) A large quantity of competitively priced land is available for industrial use in Pietermaritzburg. ✓

B. CONTRIBUTION AND LIMITATIONS

The industrial location analysis made a definite contribution to knowledge on the Howick Study Area, and the location of industries therein. This knowledge enabled planning decisions to be made.

The problem also tests or illustrates the Ecological approach. A synoptic examination of inter-related criteria and features bearing on the problem was undertaken. The following criteria and their inter-relationships were considered: physical, biological and human features; physical infrastructure and economic factors; pollution and the spread of disease; tourism recreation and aesthetic factors.

The study was limited by the absence of comprehensive information on the air movements and limnological properties of Lake Midmar. Air, water and together with soil form the three great natural resources. A further limitation was imposed by the time available and the scope of the Study Region, which excluded Zwartkop Native Reserve and Edendale. Adequate attention could thus not be devoted to the consideration of human features and the human infrastructure, as in the Viljoen and van Zyl Study which concentrated on Zwartkop Reserve.

C. RECOMMENDATIONS

- (1) It is recommended that any large scale industrial development within or around Howick be prevented as it would conflict with the recreational and residential uses; increase the problems attached to the development of the non-White township on the shores of Midmar Lake; create the danger of aquatic and atmospheric pollution; and would be of greater social cost than benefit to the community.
- (2) Arising from the absence of scientific data it is recommended that (a) a micro-climatic survey be made of the Howick Sub-Region, and that
 - (b) a hydro-biological and hydrological survey be made of

the limnology of Lake Midmar and Albert Falls Dam.

(3) Due to the limitations on the study field, the human factors in the Zwartkop Reserve were not considered. It is recommended that a comprehensive survey of the Pietermaritzburg Metropolitan Region be undertaken, so as to integrate this work and study with unconsidered factors.



Would be better
present first
- as indicated
in several
places

A. SUMMARY

The work set out to consider the utility of the Ecological Approach for Physical Planning (i.e. land use Planning). Five basic approaches to physical Planning were detected, and the ecological approach and method stated, in Chapter 3.

Three land use tests or problems were considered in the context of the environment, and the inherent characteristics which nature possessed for exploitation, in the form of land usage.

In Chapter 2, the background to the region was provided. The literature survey was followed by a survey of the physical, sociological and economic features of the Three Rivers Region. This background was used and interpreted in the first problem.

In Chapter 4, the first problem or test was to conduct a survey of the physical features of the Howick Sub-Region. The survey began with an introduction to some ecological principles, namely the inter-relationships between the physical characteristics; with a comment on how these characteristics could inform planning. The physical features were subdivided into physiographic subregions (considering topography, geology and hydrology) and the bioclimatic subregions (climate vegetation and soils particularly). These physical characteristics were inter-related in agro-ecological areas from which the agricultural capabilities were deduced. This enabled the prediction or recommendation of agricultural and general recreational land usage throughout the Howick Sub-Region.

In Chapter 5 the focus was narrowed on to the Howick-Pietermaritzburg Study Area. The second test was to consider the need for open space in usage within the Study Area. In the general motivation or goal formulation recreation, conservation, economics of leisure and tourism; psychological and social pathology were considered. Having shown a definite need, the Study Area was surveyed for areas suitable for open space. The survey was conducted within the separate Bioclimatic Groups. The alternative land uses of built up used open space and agricultural suitability, were examined. The physical survey was followed by a brief socio-economic survey as a cultural check upon the intrinsic physical suitabilities. The chapter concluded

with the proposals for a green open space system following the Pietermaritzburg -Zwartkop escarpment, and a major recreational axis uniting the two major water impoundments, Midmar and Albert Falls Lakes. The need to preserve the areas nearby the lakes or on the margins of the watersheds against built up intrusions was shown, notably at Howick-West, Mpophomeni and Merrivale. The analyses also showed that land uses are not necessarily mutually exclusive, in fact they are often compatible.

In Chapter 6, the third problem on industrial location analysis was investigated. The method adopted was firstly to detect areas where industrial development would be the most feasible. A series of sieves excluded the most expensive and impractical sites. In the second phase of the analysis the economic viability of the optimum site (Tweedie area) was examined. After considering factors of industrial location, and property economics, the Tweedie site was concluded to be probably inviable for industrial development in the Study Area. After considering aspects such as landscaping and recreation, pollution and public health, communication and infrastructure costs, the conclusion is reached. The conclusion or evaluation rejected major industrial development within the Study Area, until such time as the detrimental social consequences can be shown as not being applicable.

B. RECOMMENDATIONS

Following from the open space survey in Chapter 5, the following recommendations were made :

- (1) In keeping with the intrinsic land suitabilities, it is recommended that provision be made for a green open space, undeveloped natural landscape or woodlands system to encircle Pietermaritzburg and continue along the Umgeni valley and Zwartkop escarpment.
- (2) In keeping with the open space system's proposals and the socio-economic features, that (a) the two local authority areas of Sweetwaters and (b) Winterskloof be amalgamated, and that subdivisions exceed 2 hectares (5 acres).
- (3) In order to conserve and enhance the impounded water resources it is recommended that (a) the Umgeni-Karkloof gorges and valley be reserved for conservation and recreational use; (b) the periphery of the Umgeni Nature Reserve and Midmar Valley be reserved for agriculture to be controlled by the Department of Agriculture and Technical Services in order to prevent erosion; and (c) the area between the Midmar Lake and

the Boston Road watershed be reserved for agriculture and not be allocated to residential use.

(4) Arising from the close relationship between major dams and recreation it is recommended that representations be made to the Department of Water Affairs, to indicate the desirability of co-ordinated recreational and water-resource planning, particularly with regard to the purchasing of land on the margins of proposed dams.

(5) Following from the absence of adequate scientific data it is recommended that:

- (a) the desirability of making available more plots of varied size be investigated;
- (b) the possibility of residential areas and high density development adjacent to permanent agricultural areas, such as Cedara College, be investigated.

(6) With regard to the high demand for land and the population increase, it is recommended that Howick-West be expanded in the future (preferably up to the Boston Road) and that suitable representations to this effect be made in the appropriate quarters.

(7) Taking cognisance of the probability of the pollution of a major water resource, and to a lesser degree landscaping considerations; the creation of a health hazard; and possible conflicts in terms of abutting high and low income areas; it is recommended that representations be made in suitable terms to the appropriate bodies, that no expansion of Zwartkop Reserve or that no other Bantu Area be permitted in the Midmar Catchment Area, or in the area of white owned farms between the Umgeni Valley and Zwartkop Reserve.

The industrial location analysis in Chapter 6 led to the following recommendations :

(1) It is recommended that any large scale industrial development within or around Howick be prevented as it would conflict with the recreational and residential uses; increase the problems attached to the development of the non-White township on the shores of Midmar Lake; create the danger of aquatic and atmospheric pollution; and would be of greater social cost than benefit to the community.

(2) Arising from the absence of scientific data it is recommended that (a) a micro-climatic survey be made of the Howick

Sub-Region, and that

(b) a hydro-biological and hydrological survey be made of the liminology of Lake Midmar and Albert Falls Dam.

(3) Due to the limitations of the study field, the human factors in the Zwartkop Reserve were not considered. It is recommended that a comprehensive survey of the Pietermaritzburg Metropolitan Region be undertaken, so as to integrate this work and study with unconsidered factors.

C. CONCLUSION AND LIMITATIONS

In assessing the ecological approach the first factor to consider are validity and reliability. Validity may be interpreted by asking the questions, are the sources genuine and accurate, or does the method measure what it purports to measure? Almack (1930) stated that the test for validity in both the historical and normative methods may be the criterion of expert witnesses. The sources of the data may be considered to be valid as in all cases the testimony of experts was sought, and cross checked against one another.

Reliability relates to the extent to which consistent measurements and results were obtained, i.e. if the test were to be repeated the results would be the same. In the normative method the results may be retested; or use the split test method. The only previous investigation which could be comparable relates to the industrial location analysis, where the conclusion was also against industrial development, though for partly different reasons. (This comparison approach is not entirely satisfactory as McHarg (1969) noted: the fact that his proposals differed radically from the accepted Washington 2000 plan, could be interpreted as supporting his views). Almack (1930) states, "agreement is in fact the ultimate test of reliability of anything." He submits that when ascertaining reliability in the historical method, testimony or results which agree with dependable reasonable opinion or testimony are reliable. The proposals and recommendations were accepted and approved by two bodies of experts and distinguished citizens. In this sense the method as applied may be said to have produced valid and reliable results.

Another means of assessing a planning method is to consider its ability to assist decision-making by revealing priorities, disclosing inherent uses for the land, or by identifying and selecting between alternative land uses. The ecological method

has satisfied these criteria ^{also}. The approach revealed the intrinsic uses for land in the physical and agricultural survey chapter - and also in the open space analysis. The method ^{also distinguishes} ~~was also able~~ to distinguish between competitive alternatives and priorities as was also shown in the open space and industrial location analyses.

The major limitation to the work was the scape or terrain bounded by the Sub-Region. The city of Pietermaritzburg and Zwartkop Bantu Reserve were only considered in passing. A major metropolitan survey is required. (On the other hand, the Howick Sub-Regional Survey was also intended as a step towards a plan for the capital and its environs.) The study was also limited by the absence or unavailability of scientific data, e.g. for wind movements and soil suitability for septic tanks or high density residential development. These limitations have indicated fields for further investigation and were, thus, represented in the recommendations. Finally it should be noted that the survey does not purport to be a plan, as the nature and implementations of social objectives was not considered. This does not nullify the results, as McHarg (1969) pointed out, but it does indicate a limitation to the scope of the study.

In conclusion it may be said that the work has contributed to the knowledge and understanding of the Howick Sub-Region by providing a synthesis of information on the Region and Sub-Region; stating and interpreting the agricultural potential for the Sub-Region; revealing inherent open space land uses and establishing priorities and information on industrial development within the Howick Study Area; while also detecting areas for further investigation.

afm

LEAD
EFFICIENT
CONCENTRATED
INDUSTRIAL
EXISTING

SOIL
DATA
ARE

AVAILABLE
BY
EXTRA 10-11-67

JP

(after Faul, 1966)

Major Divisions (Era/Group)		Boundary Ages (m.y.)	Subdivisions (Period/System)	Duration Million Years	
C A I N O Z O I C	QUATERNARY		RECENT	± 10,000 yrs.	
			PLEISTOCENE	2	
	TERTIARY	2			
		7		PLIOCENE	5
				MIOCENE	19
		26			
		38		OLIGOCENE	12
				EOCENE	17
		55			
				PALEOCENE	10
	65				
MOSEZOIC			CRETACEOUS	70	
	135				
			JURASSIC	55	
	190				
PALAEZOIC			TRIASSIC	35	
	225				
			PERMIAN	45	
	270				
			CARBONIFEROUS	70	
	340				
			DEVONIAN	60	
	400				
			SILURIAN	30	
430					
		ORDOVICIAN	70		
500?					
		CAMBRIAN	100		
600?					
PRECAMBRIAN			Worldwide sub- divisions not well established	± 3,500	

Population	Durban		Pietermaritzburg		Non-Metropolitan		Total	Three Rivers Region		
	1960	2000	1960	2000	1960	2000	1946	1960	1980	2000
WHITES Population Per cent rate	196,000 2.8	587,000 2.8	40,000 2.3	98,000 2.3	26,000 2.2	67,000 2.5	178,000 2.8	262,000 2.7	443,000 2.7	752,000 2.7
COLOURED Population Per cent rate	27,000 4.8	124,000 3.7	6,000 4.5	25,000 3.7	2,000 2.5	1,000 1.0	17,000 3.6	34,000 4.2	73,000 3.9	150,000 3.6
ASIATICS Population Per cent rate	234,000 3.9	825,000 3.0	27,000 3.7	100,000 3.0	83,000 1.8	162,000 1.6	196,000 2.5	344,000 3.3	630,000 3.1	1,088,000 2.8
BANTU Population Per cent rate	206,000 2.7	691,000 2.7	56,000 4.9	201,000 3.0	493,000 1.2	520,000 0.2	564,000 1.6	754,000 2.4	1,040,000	1,412,000 1.5
TOTAL Population Per cent rate	663,000 3.2	2,227,000 2.9	129,000 3.8	425,000 2.9	603,000 1.9	750,000 0.5	955,000 2.0	1,395,000 2.7	2,186,000 2.3	3,402,000 2.2

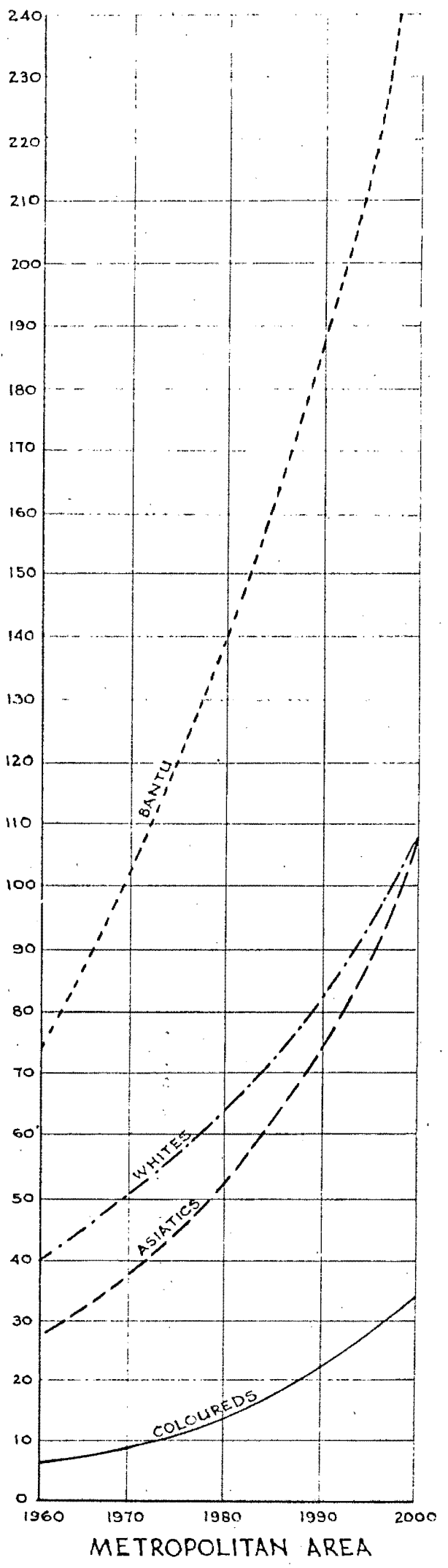
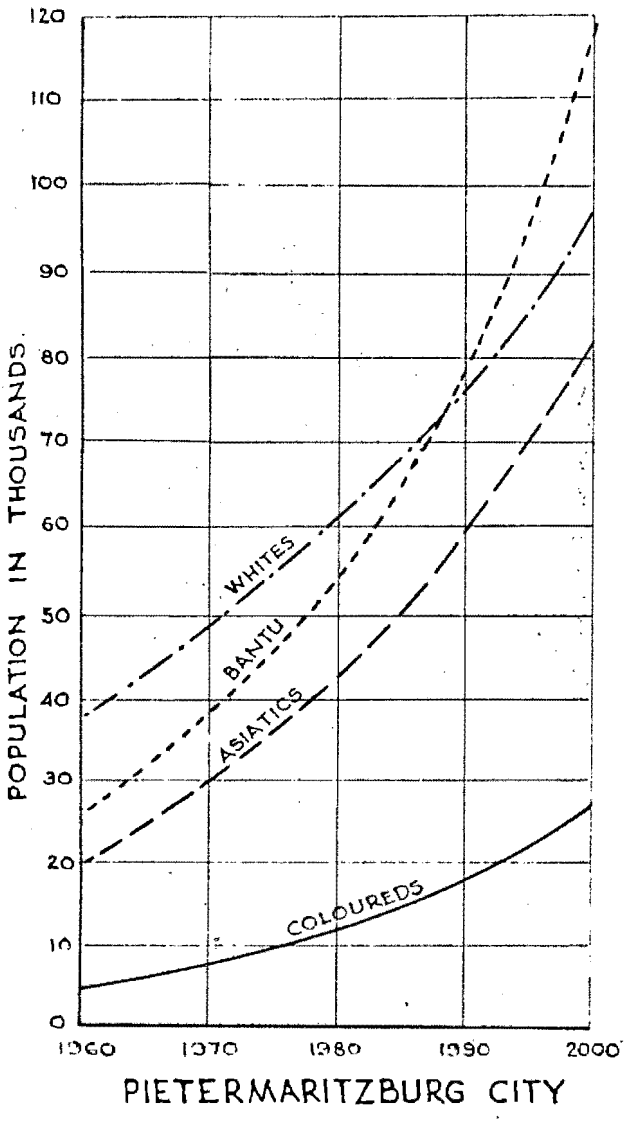
Source: Pietermaritzburg-Durban Planning Committee (addendum to Bs B4).

NOTE : Figures rounded to nearest thousand

APPENDIX 2A

Howick
Sub-Regional Survey

POPULATION ESTIMATES:
PIETERMARITZBURG CITY
& METROPOLITAN AREA.



APPENDIX 3 COMPARISON OF TERMINOLOGY FOR SUB-REGIONS OR ZONES WITHIN THE HOWICK SUB-REGION

MAP 2E	-	MAP 2J	-	MAP 2J	GENERAL LOCATION
VEGETATION A	CLIMATIC	Ecological Vegetation	Numbers Names	BIO-CLIMATIC	
Highland Grassland with Montane <u>Podocarpus</u> forest	1 Humid and cool	1a - Highland		4e - Open Grassland to wooded Savanna Humid to SubHumid	Highland (Sourveld)
Mistbelt <u>Themida</u> - <u>Aristida</u> Grassland, with mixed <u>Podocarpus</u> forest	2 Humid and mild	1b - Midlands Mistbelt Grasslands		3a, 3c - Mistbelt Forest & wooded Savanna Humid to SubHumid 3d Sub Humid	Midlands Mist Belt 5000 Ft.
Mist Belt <u>Themida</u> - <u>Aristida</u> Grassland with mixed <u>Podocarpus</u> forest	3 Moist sub-Humid and cool	2c - Highland Sourveld (Border Tugela Basin)		4e - as above	Border on to Tugela Basin
Moist transitional <u>Themeda</u> - <u>Hyparrhenia</u> Grassland	4 Moist sub-humid and mild	2a - Moist grassland transitional to Midlands Mistbelt		6a - Open grassland to wooded Savanna Sub Humid - mild Sub Arid	Dargle Valley
Moist transitional <u>Themeda</u> - <u>Hyparrhenia</u> Grassland	5 Slight dry to dry sub-humid mostly cool	2d* - Cool dry ectronal Grassland. North of Mooi River		6a - above	-
<u>Acacia</u> - <u>Sieberana</u> Savanna	6 Slightly dry Sub Humid and mild	2b - Moist tall grass-land (Merrivale Valley)		6a - above	Midmar Valley
Dry valley Scrub and Woodland Mosaic	7 Dry Sub-Humid and Mild to warm	3b - Mixed bush of the Umgeni Gorge		10a - Riverine & Lowland Mixed Scrub and wooded Savanna. Mild Sub-Arid to Sub-Arid	Umgeni Gorge
MOLL (1965, 1967)	SCOTNEY (1970)	PHILLIPS (1969)			
NOTE * Indicates area as predominantly lying outside the Howick Sub-Region					

Group No.	Rainfall		Temperature Range Warmer and Cooler Seasons	Temperature Mean Annual Range : C°	Frost and Snow	Evaporation Mean Annual Total Range: mm and (inches) Symons Tank: Goosen 1958 and W.B. 28/1965
	Range in mm and (inches): Mean Annual	Distribution by Very Wet (VW) Medium Wet (MW) Ecologically Dry (ED) months				
2	850/1,300 (33.4/51.2)	VW: 5-6 MW: 7-6 ED: 0	Warm/Mild to Mild	17.5/20	Frost 0 to rare to occasional; light to locally moderate (may "frost" sugarcane moderately) (snow 0)	1,270/1,295 (50/51)
3	800/1,600 (31.5/62.9)	VW: 5-6 MW: 7-6 ED: 0 (rarely 1)	Mild/Cool to Cool/Cold	16/18	Frost 0 to rare to occasional; light to moderate to locally moderately-severe, (may "frost" sugarcane moderately severely); (snow rare on highest points)	1,270/1,346 (50/53)
4	800/1,500 (31.5/59.1)	VW: 5-6 MW: 5-3 ED: 2-3	Mild/Cool to Cool/Cold occasionally very cold	13/15	Frost over long period moderate to severe; (snow locally for short periods)	1,270/1,346 (50/53)
6	800/1,000 (31.5/39.4)	VW: 5 MW: 4 ED: 3	Warm/Mild to Cool/Cold	16/18	Frost over several months; moderate to severe; (snow local, short periods)	1,346/1,448 (53/57)
10	600/700 (23.6/27.6)	VW: 2-4 MW: 6-4 ED: 4	Hot/Warm to Warm/Mild and Warm to locally Hot/Warm/Mild	18/23 Warmer in N.E. Faciation	Frost in Riverine faciation only, in Basin and S.W. Surrounds moderately severe, nil in N.W. Lowveld faciation; (snow 0)	1,448/1,524 (57/50) Increases to N.E.

Source : Phillips 1970 (B)

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DEPT. OF AGRICULTURE & T.S.,	Howick Extension Officer.
----- BANTU AFFAIRS,	Commissioner for Natal, Chief Engineer, Chief Planning Officer, Townships Engineer, Montrose Superintendent.
----- COMMUNITY DEVELOPMENT,	Regional Representative.
----- PLANNING,	Regional Representative.
----- RAILWAYS & HARBOURS,	District Engineer.
----- STATE HEALTH SERVICES,	Chief Regional Research Officer.
----- TOURISM,	Regional Representative.
----- WATER AFFAIRS,	Resident Engineer, Midmar.
DEVELOPER OF PROPOSED INDUSTRIAL TOWNSHIP, Tweedie.	
E.S.C.O.M.	Planning Officer.
HILTON COLLEGE,	^a Bursar, Headmaster.
HOWICK CORPORATION,	Town Clerk.
NATAL LOCAL HEALTH COMMISSION,	Planning Officer, and Secretaries or Chairmen for the following local Health Committees:- Cedara, Hitton, Merrivale, Sweetwater, Winterskloof.
NATAL PARKS BOARD,	Director, Assistant Director.
NATAL ROADS DEPARTMENT,	District Engineer, Planning Officer.
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B I B L I O G R A P H Y

Abbreviations used in the Bibliography

C.S.I.R.	Council for Scientific & Industrial Research.
J.A.I.P.	Journal American Institute of Planners.
J.R.T.P.I.	Journal Royal Town Planning Institute. (Recently awarded Royal Charter)
N.I.W.R.	National Institute of Water Research - part of the C.S.I.R.
N.T.R.P.	Natal Town & Regional Planning Commission.
N.R.S.	National Regional Survey Series (associated with the University of Natal)

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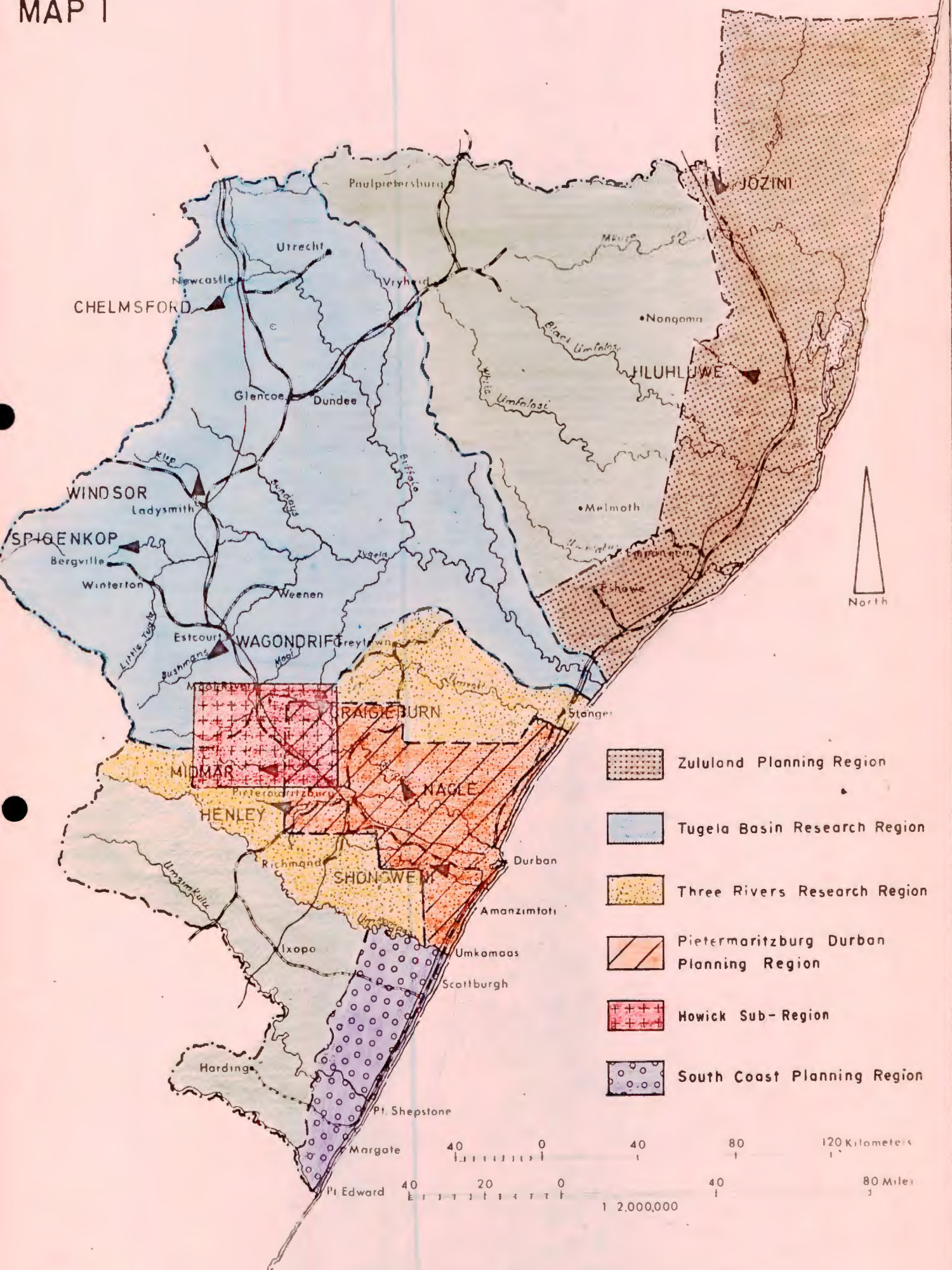
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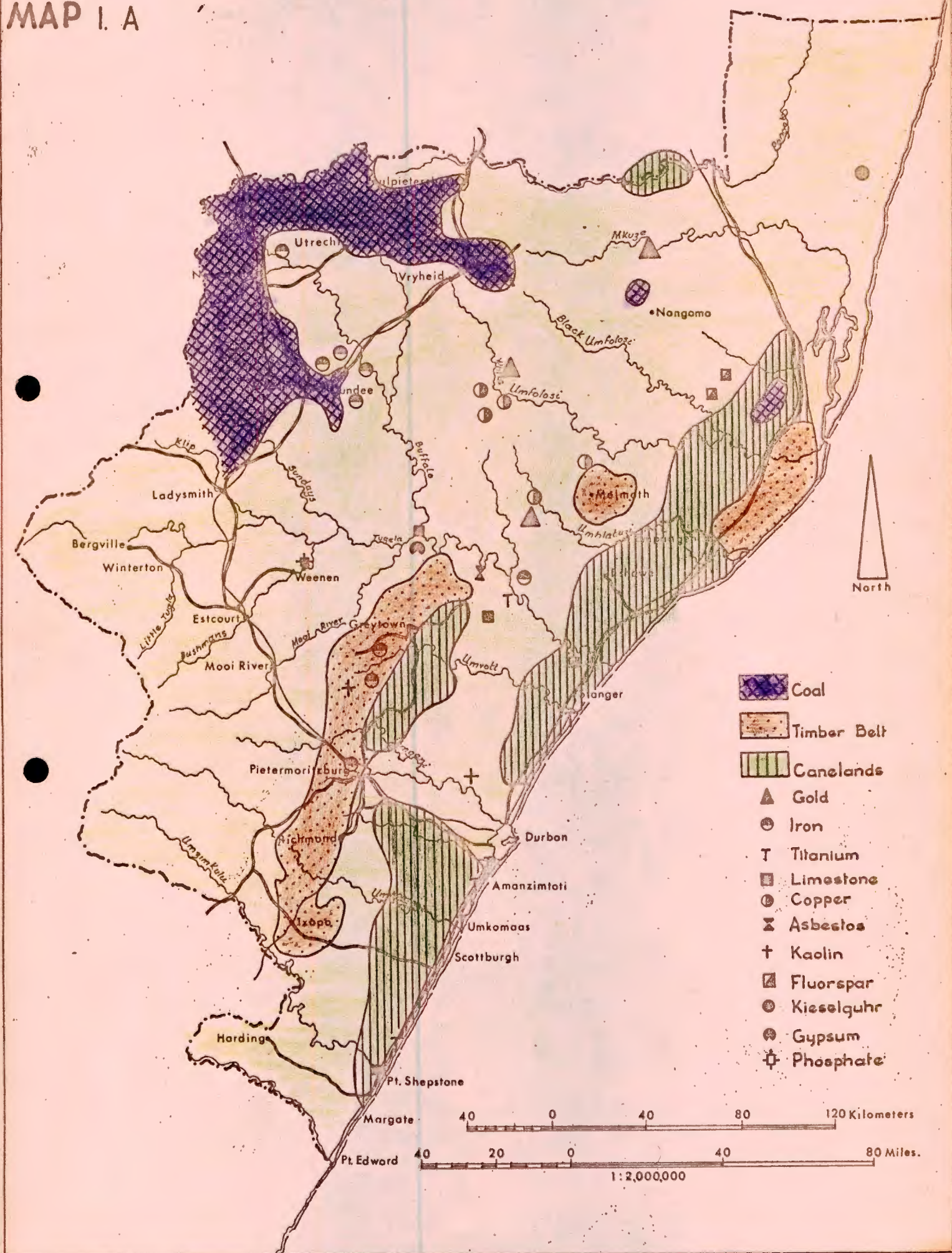
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2

1



MAP I. A



HOWICK SUB-REGIONAL SURVEY

ROADS, RAILS & DAMS

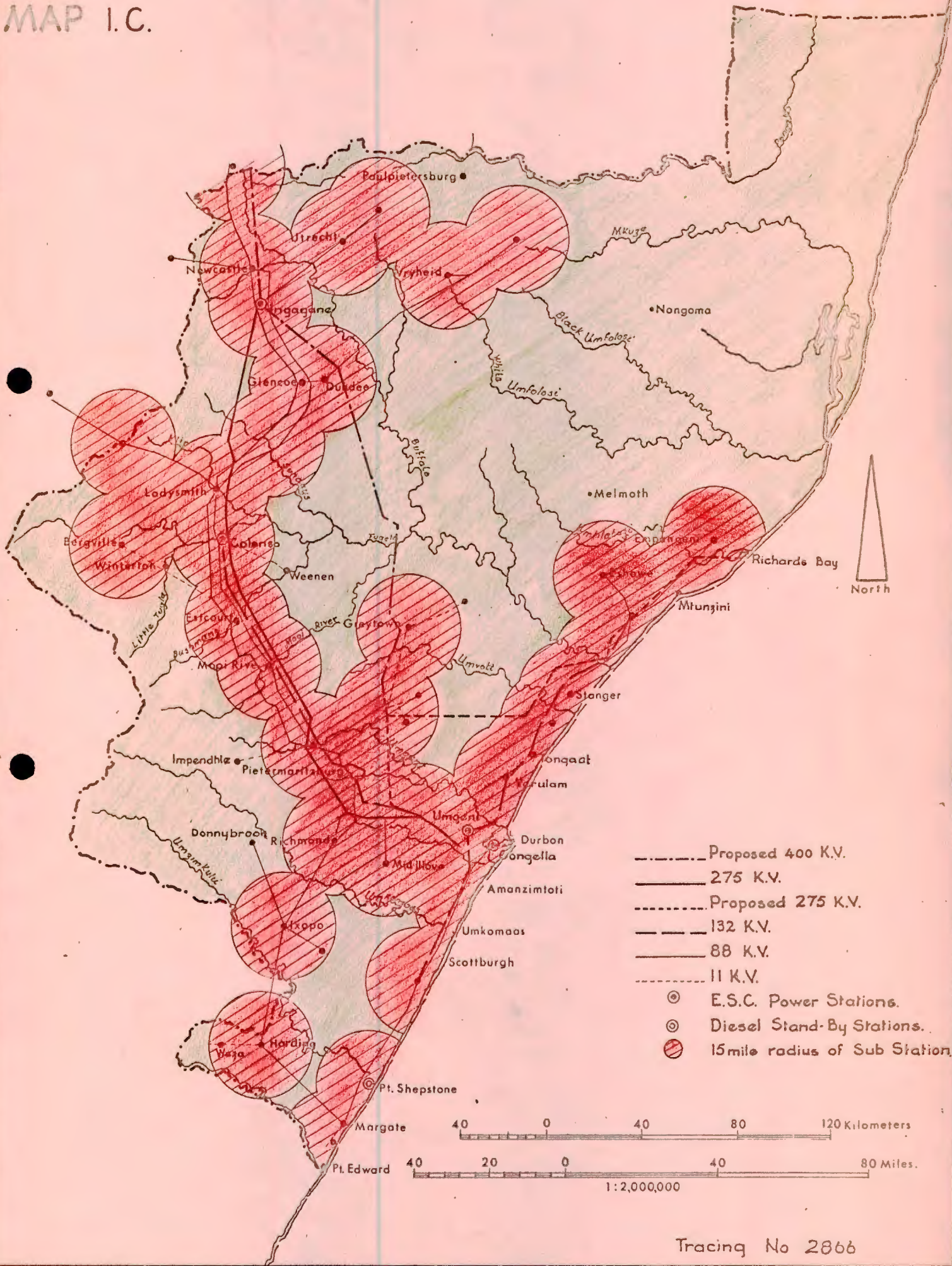
MAP I.B.



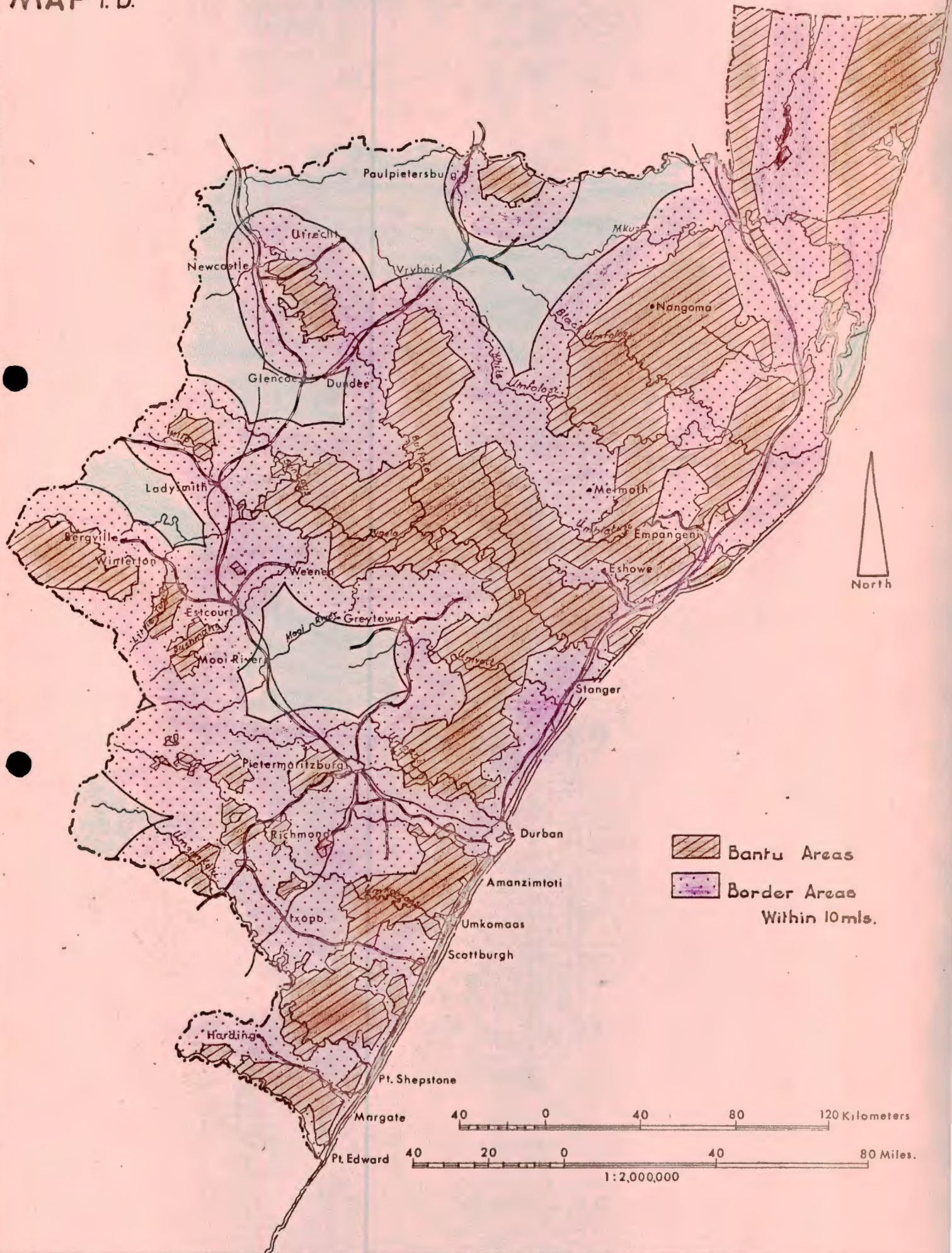
HOWICK SUB-REGIONAL SURVEY

ELECTRICITY SUPPLY

MAP I.C.



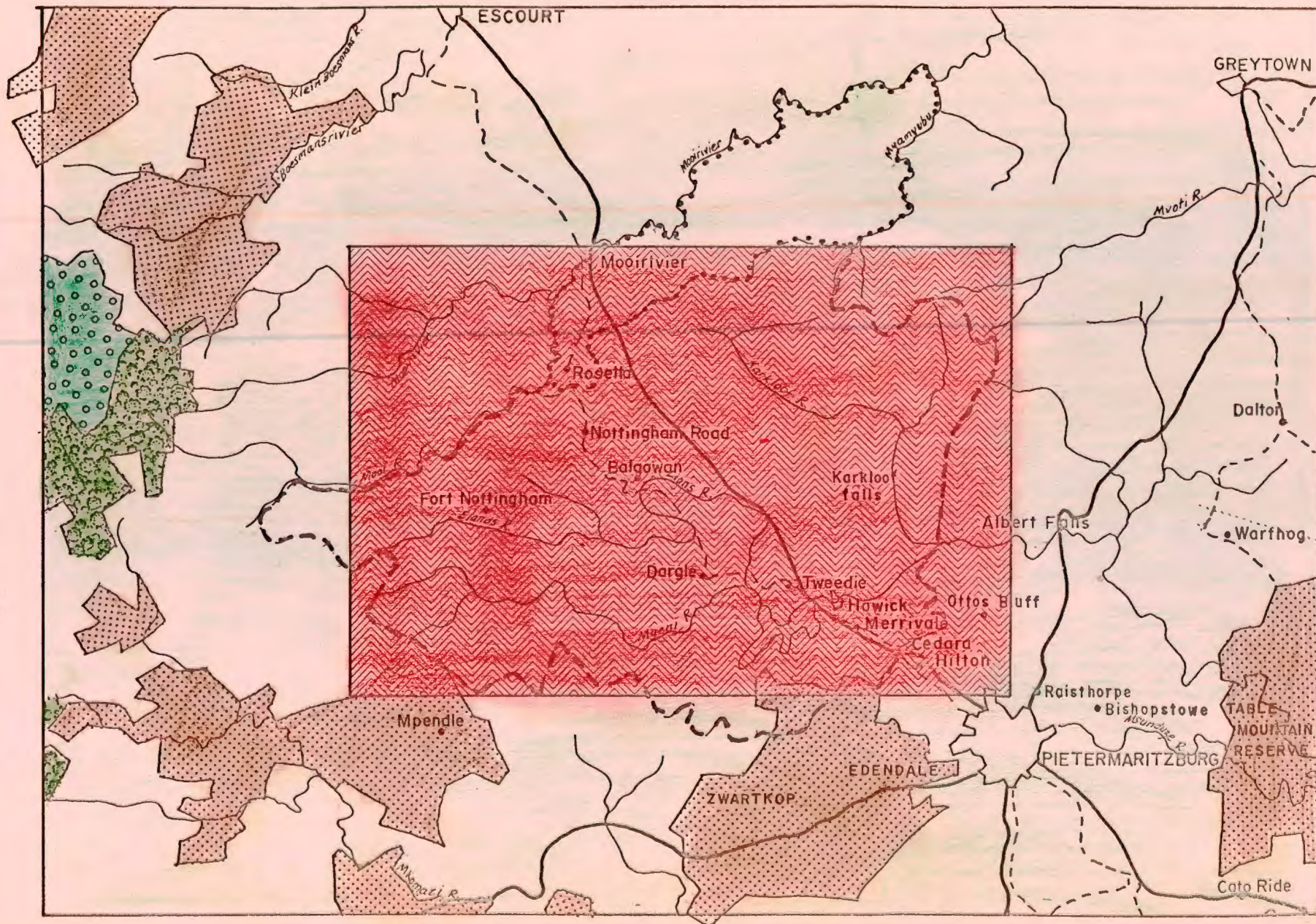
MAP I.D.



LOCATION OF STUDY AREA

MAP I F

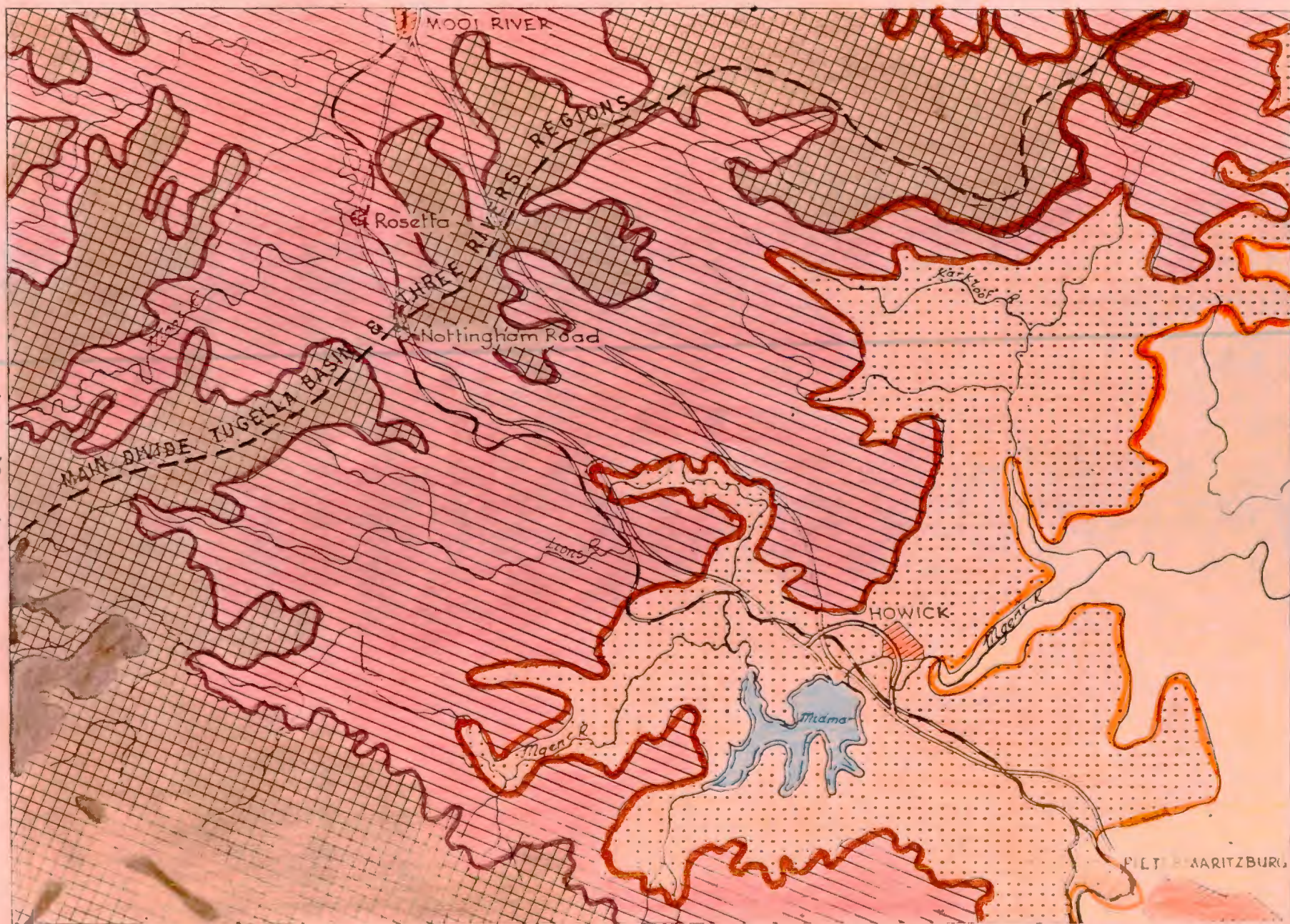
-  STUDY AREA
-  BANTU AREAS
-  FOREST RESERVE
-  GAME RESERVE
-  SOIL CONSERVATION DISTRICT BOUNDARIES
-  MOOI RIVER AREA
-  LIONS RIVER AREA



Howick
Sub-Regional Survey

TOPOGRAPHY MAP 2A

METRES		FEET
829-2133		6000'-7000'
524-1829		5000'-6000'
219-1524		4000'-5000'
914-1219		3000'-4000'
610-914		2000'-3000'



scale - 1 250,000

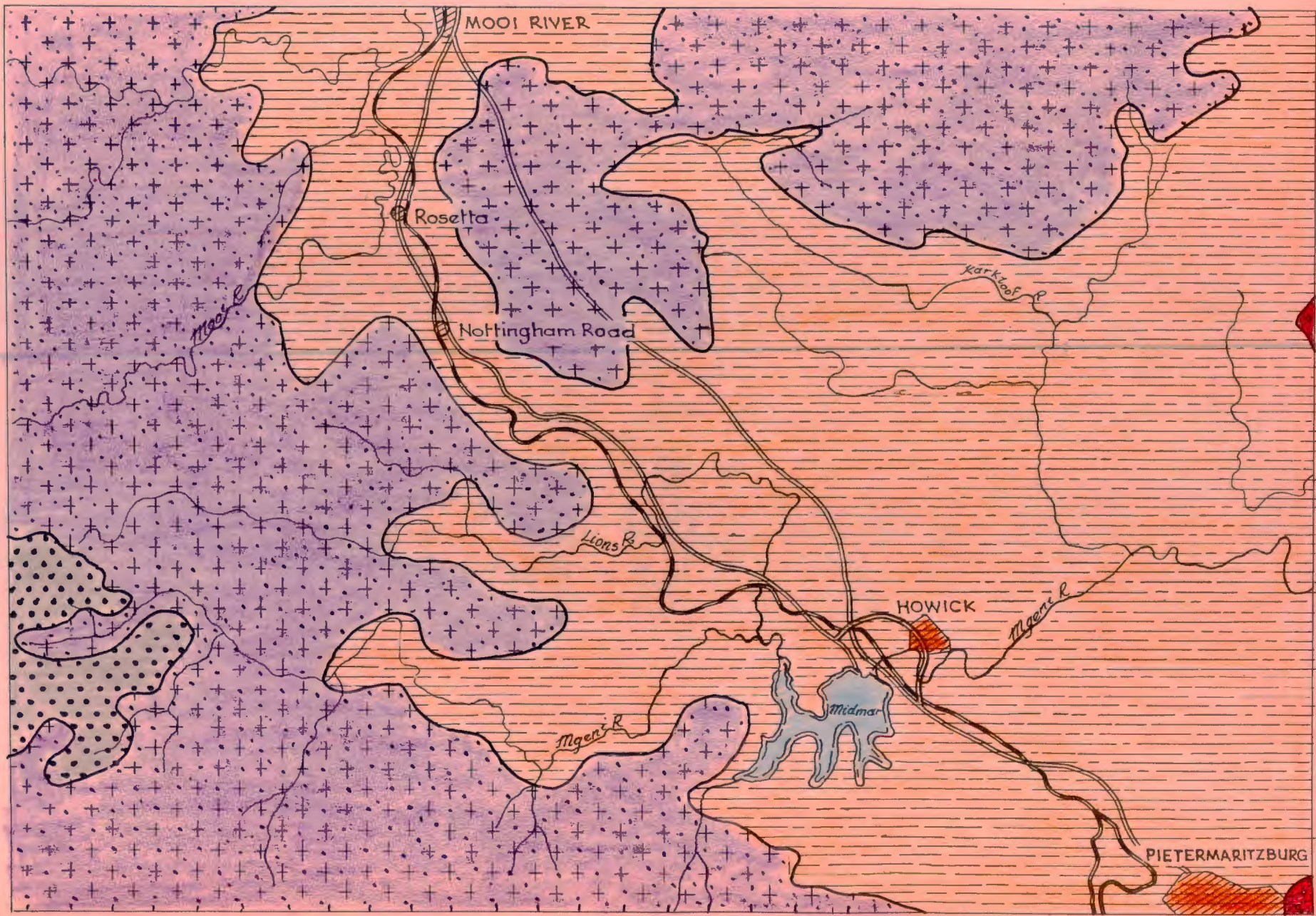
15 MILES

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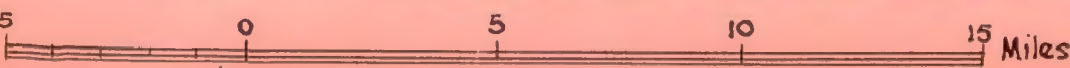
Howick
Sub-Regional Survey

GEOLOGY
MAP 2B

-  Beaufort
-  Dwyka
-  Ecca
-  Stormberg



Scale 1:250,000



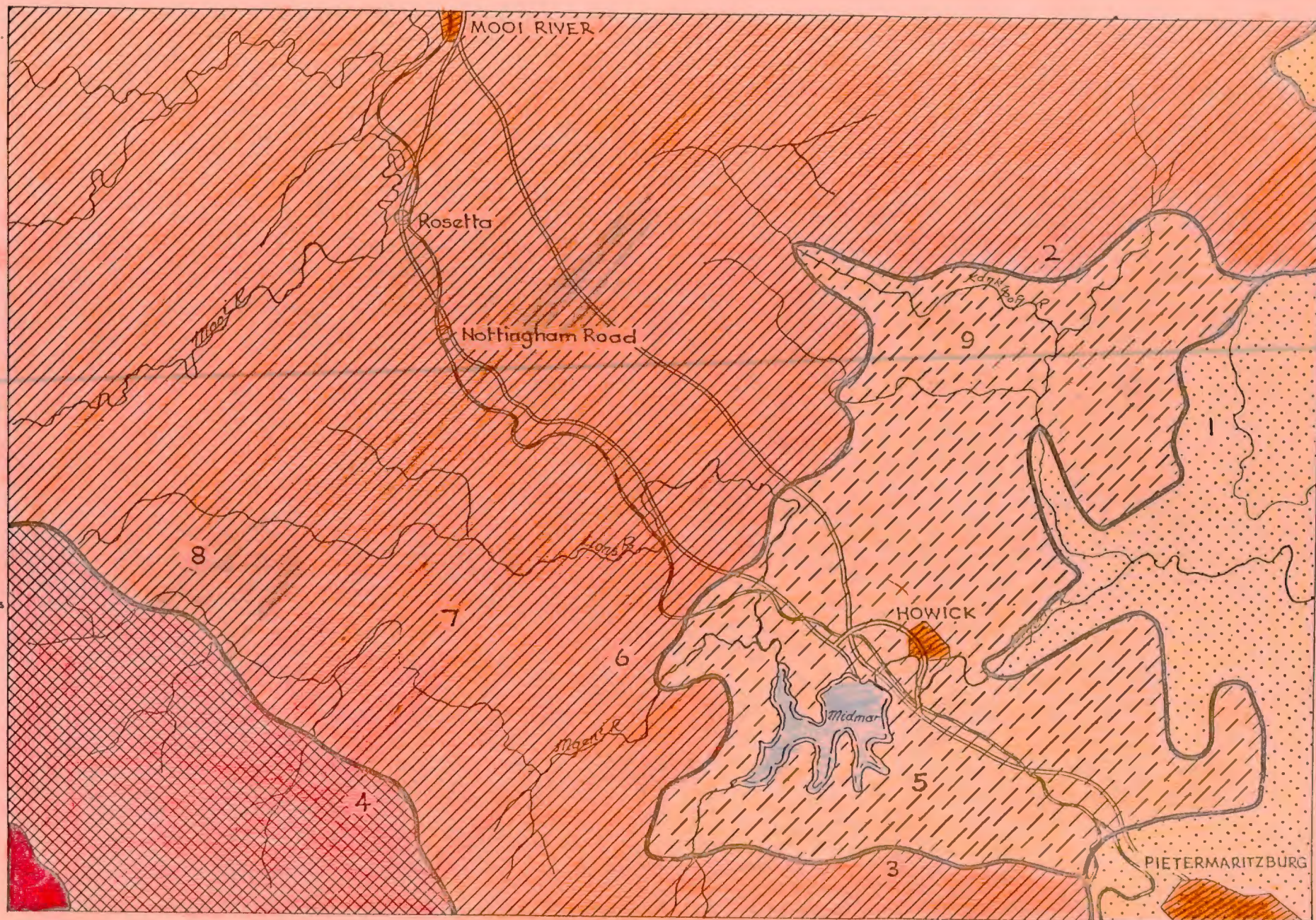
Howick
Sub-Regional Survey

PHYSIOGRAPHIC REGIONS

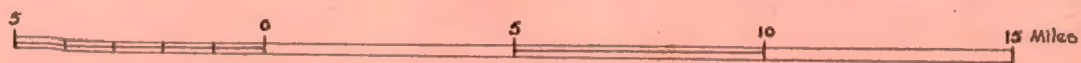
MAP 2C

(J.L. Turner)

-  Greytown - P.M.B. - Richmond Benchland
-  Howick Benchland
-  Natal Midlands.
-  Impendhle Block.
-  Incised River Valleys of Natal.



Scale 1:250,000

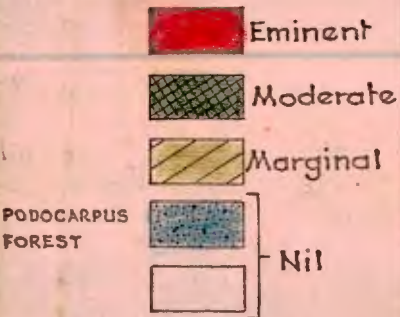


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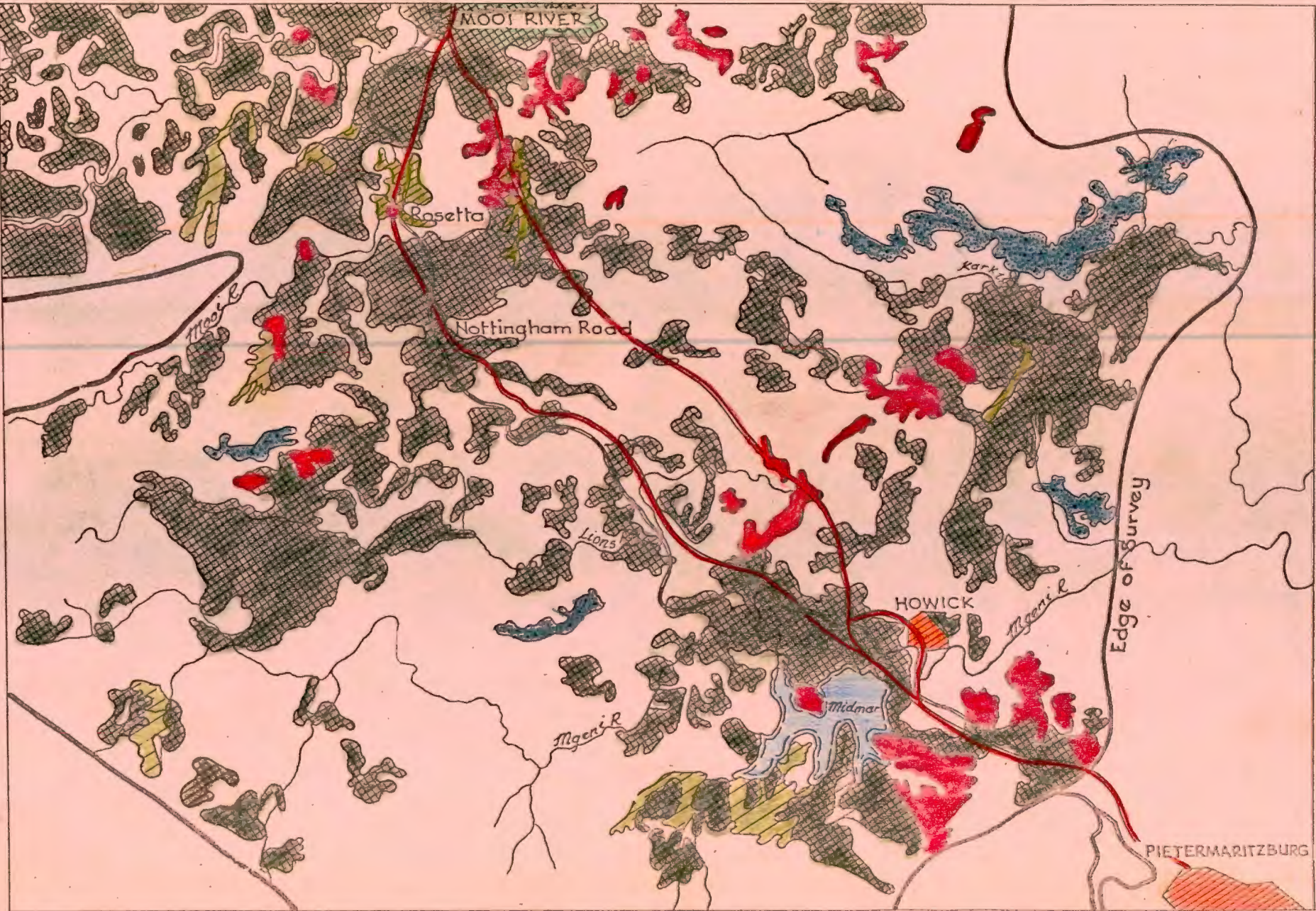
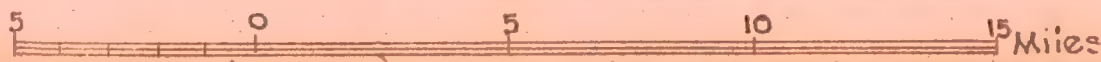
Howick.
Sub-Regional Survey

SOILS
MAP 2D

(Scotney & Ludorf)
Suitability for
Agriculture



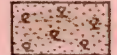
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Howick
Sub-Regional Survey

VEGETATION MAP 2E

E. MOLL

 Dry Valley Scrub & Woodland Mosaic

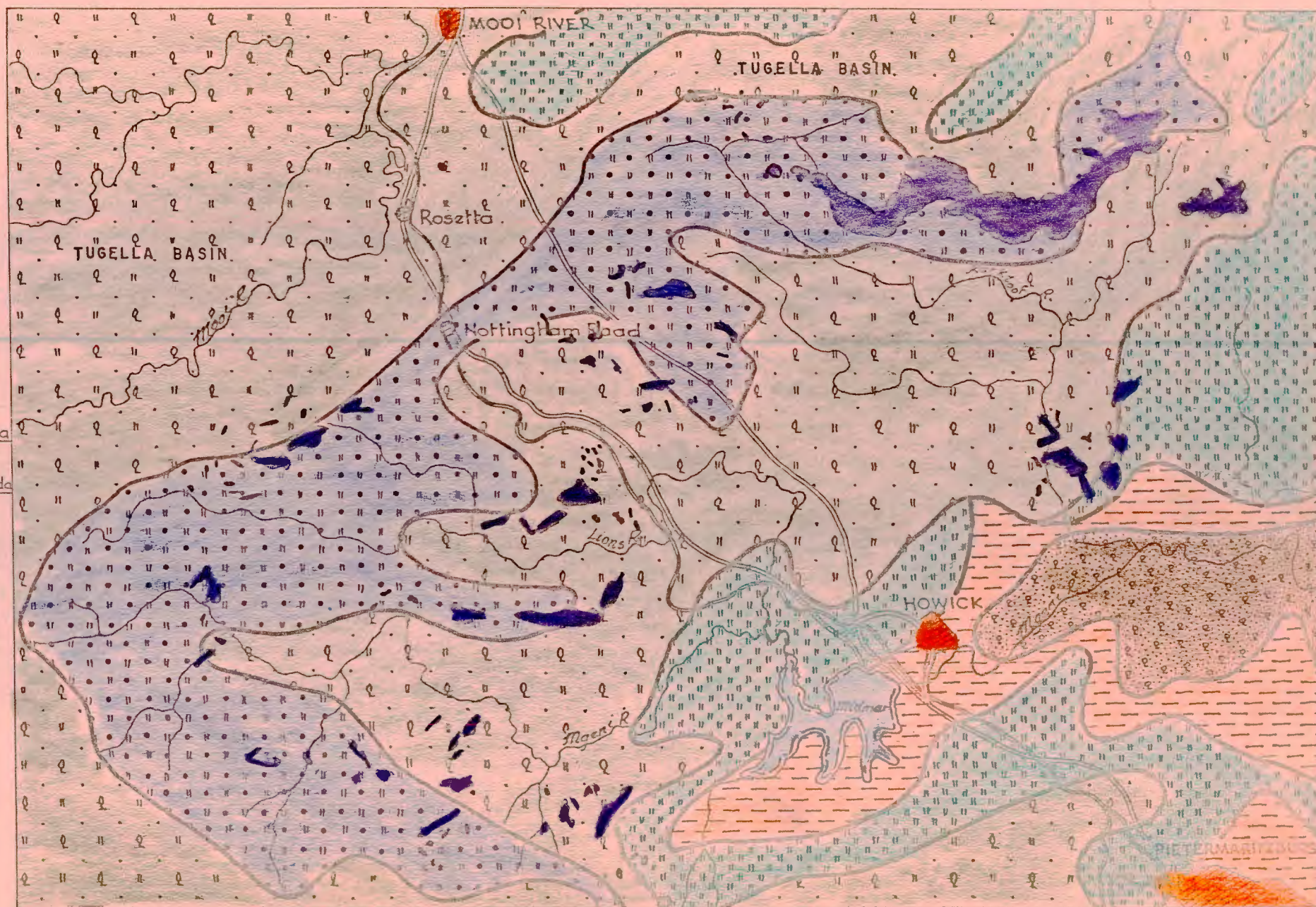
 Acacia Sieberana Savanna

 Moist Transitional Themeda-Hyparrhenia Grassland

 Mistbelt Themeda-Aristida Grassland with Mixed Podocarpus Forest

 Highland Grassland with Montane Podocarpus Forest

 Mountain and Mistbelt with Mixed Podocarpus Forest.



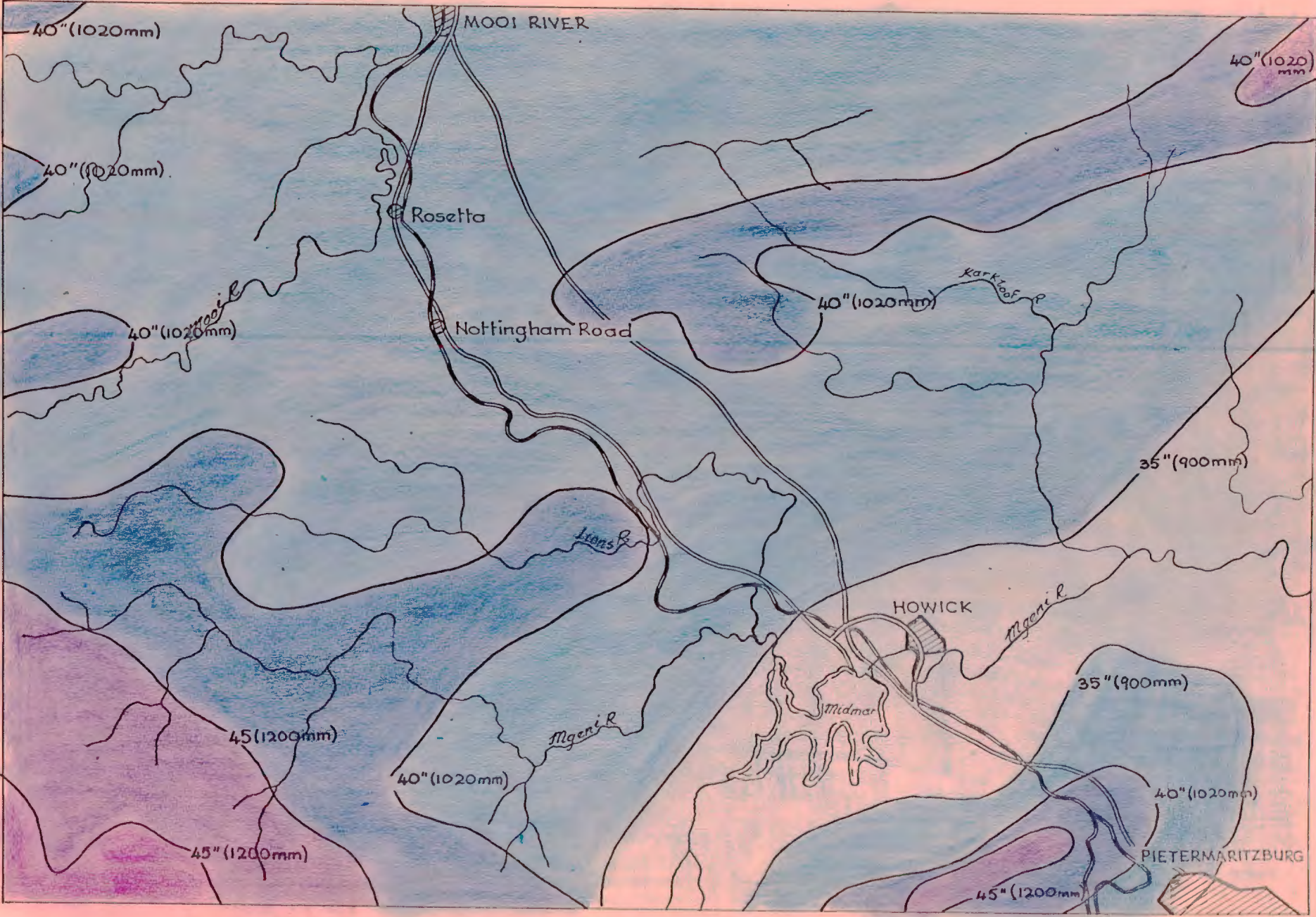
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5 0 5 10 15 MILES

Tracing N° 2988

Howick
Sub-Regional Survey

RAINFALL
MAP 2F

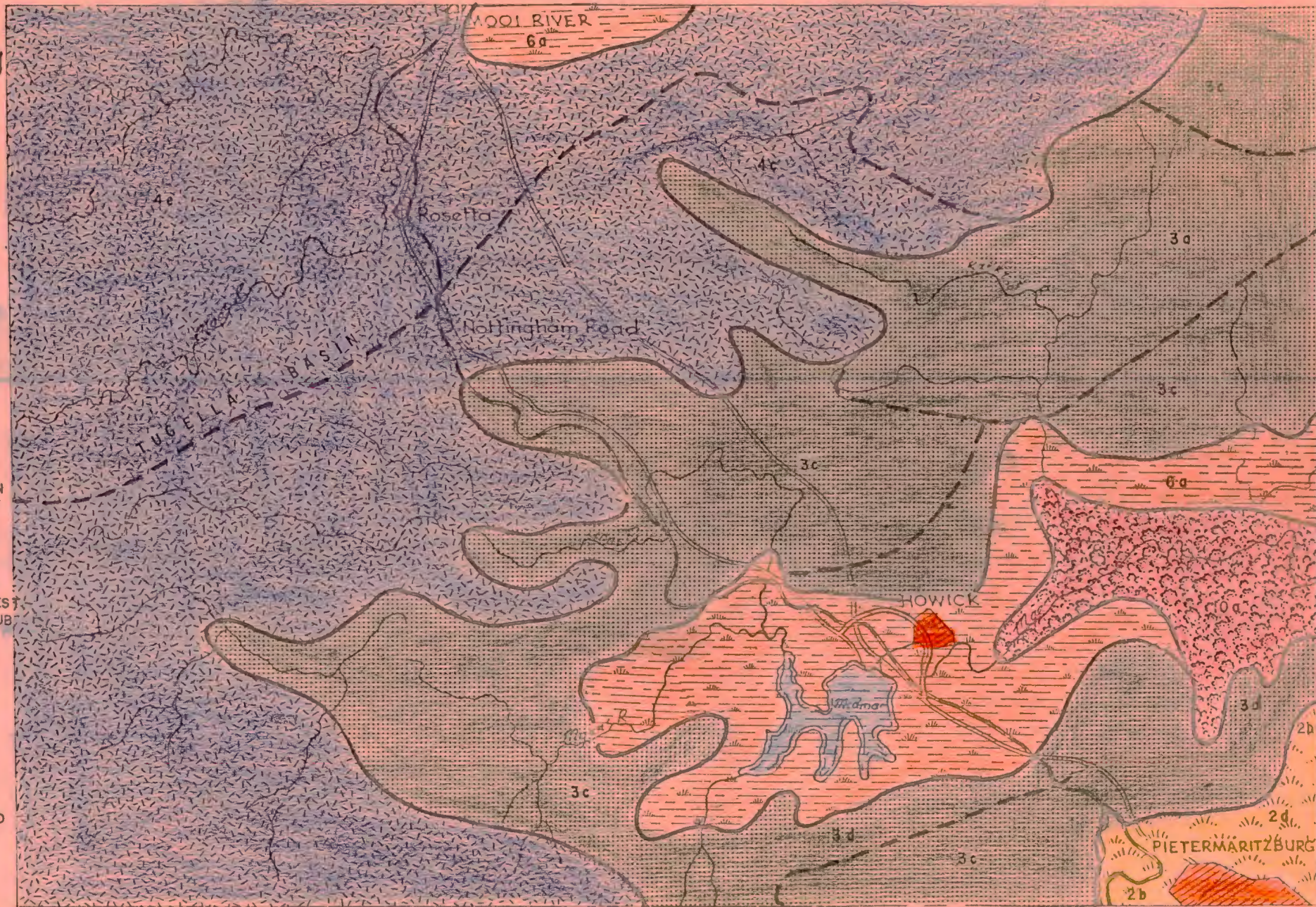


Howick
Sub-Regional Survey

BIO-CLIMATIC
SUB REGIONS
MAP 2 G.

(J.F.V. PHILLIPS, 1969)

-  2 COAST HINTERLAND:
EVERGREEN FOREST,
SHORT FOREST, BUSH &
WOODED SAVANNA.
-  3 MIST BELT EVERGREEN
FOREST, UPLAND E-GREEN
FOREST, SHORT FOREST
& WOODED SAVANNA
-  4 HIGHLAND PODOCARPUS
MIXED EVERGREEN FOREST
HIGHLAND E-GREEN SCRUB
& WOODED SAVANNA
-  5 UPLAND MIXED SCRUB
& WOODED SAVANNA
MOISTER FACIATION
-  6 SUBRID/MIXED SUBRID
RIVERINE & LOWLAND
MIXED SCRUB &
WOODED SAVANNA



40 0 40 80 120 Kilometres

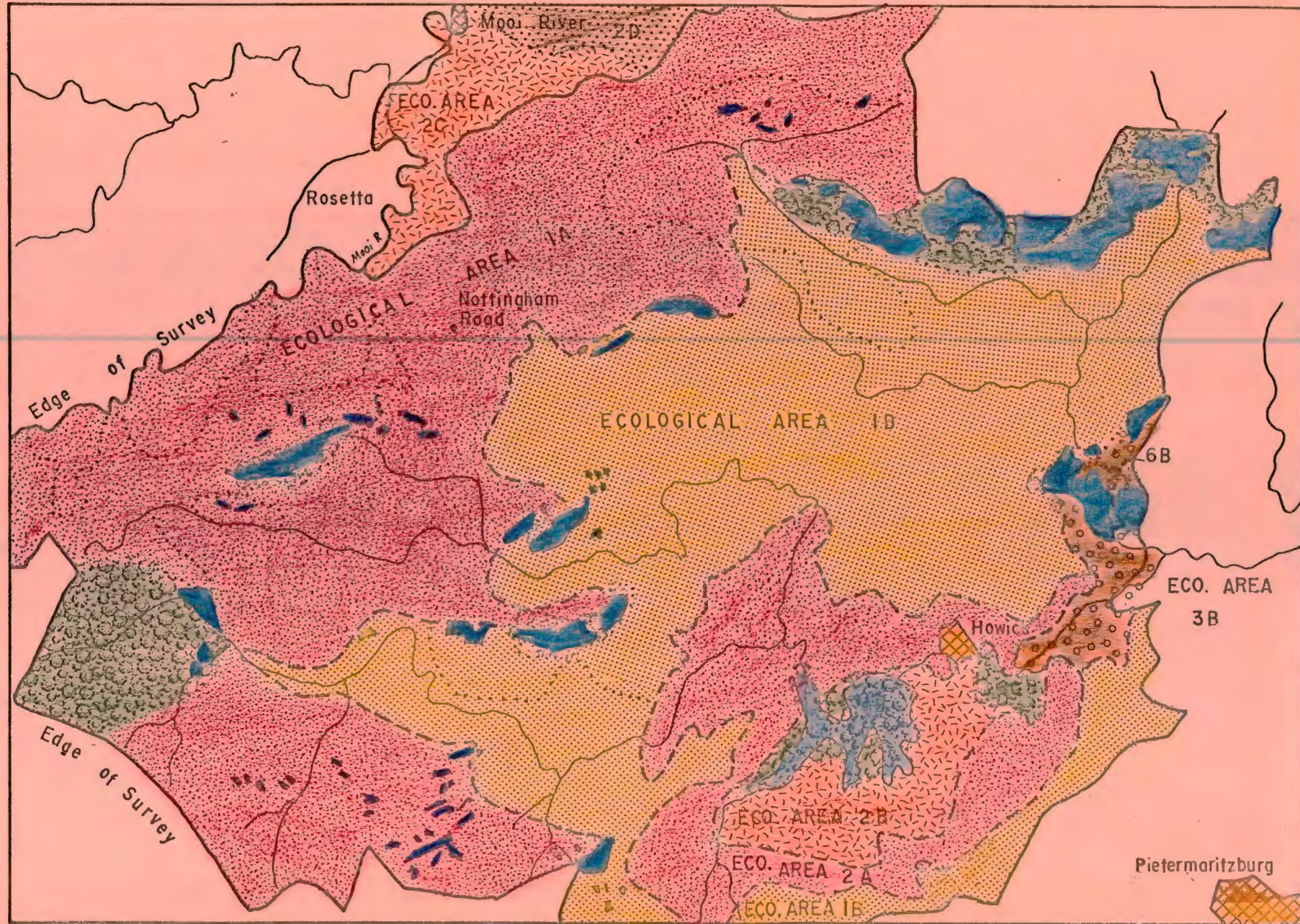
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AGRO-ECOLOGY
&
AGRICULTURAL
CAPABILITY
CLASSIFICATION

MAP 2 J

(D.M. SCOTNEY, 1970)

-  1st rate potential
-  2nd rate potential
-  3rd rate potential
-  4th rate potential
-  5th rate potential
-  Podocarpus forest
-  Existing & proposed
Nature reserves
Numbers 6A-6F
-  Boundaries
Ecological Areas
-  Capability Sub-areas



Howick
Sub-Regional Survey

AGRICULTURAL SUB-DIVISIONS MAP 4D

 dark green
Land Sub-Divisions

 Land Resistant to
Sub Divisions

pale brown / Red

Scale 1 250,000.

5 0 5 10 15 MILES

